

Emergence of plastic pollution on tourism beaches in Zanzibar, Tanzania

by
Carol Maione

April 2019

Master's Thesis
School for Environment and Sustainability, University of Michigan

Thesis Committee:
Associate Professor Rebecca Hardin, Chair
Associate Research Scientist Sara Adlerstein-Gonzalez

Acknowledgements

This research was conducted within the School for Environment and Sustainability (SEAS) at University of Michigan with unique support, encouragement, and inspiration from the faculty members Professor Rebecca Hardin and Professor Sara Adlerstein-Gonzalez, in the role of advisors. It received approval from the University's Institutional Review Board (IRB) as human subjects were engaged in the study, prior to departure, and informed consent from all participants. The expedition was carried out with the support of the Wallenberg Foundation through the "Wallenberg Summer Travel Award," of the International Institute at University of Michigan through the "II Student Fellowship," of the University of Michigan Center for Global and Intercultural Study through a study-abroad program in collaboration with St. John's University of Tanzania, Dodoma, and with additional support from SEAS. Finally, I would like to thank Zanrec Plastics Ltd, the Italian community of Zanzibar, the Italian-based NGO Social Innovation Teams, and all participants of this study for providing me with assistance on site and access to information and materials, as well as making this research possible.

Abstract

Plastic pollution is becoming a growing concern on tourism sites. Unquantified amounts of plastic materials are discharged into coastal waters and have detrimental effects on local marine environments. With the expansion of the tourism industry, waste increasingly originates from tourism activities and ends up into the ocean due to poor management of solid waste post-consumption. This study explores the source, amount, and type of waste materials in Zanzibar, Tanzania by surveying tourism activities, littering behaviors, and existing solid waste facilities. The analysis illustrates the relationship between waste management and tourism sectors. Data were obtained through interviews, one focus group, and observations at four tourism sites. Findings suggest that plastics waste is produced to a considerable extent by tourists. Especially, improper littering practices and limited engagement of stakeholders from the tourism sector into the waste regulation framework are major predictors of leakage of plastic into the ocean. Based on the findings, this study demonstrates the need for littering policy to reduce marine littering.

Keywords: Plastic pollution; Tourism; Zanzibar; Marine littering; Littering policy

List of Figures

Figure 1. Map of Zanzibar Archipelago and Unguja island including study areas	3
Figure 2. Closed loop diagram of beach and marine accumulations in Zanzibar	8
Figure 3. Waste materials recycled on work setting	9
Figure 4. Waste storage facilities on work setting	9
Figure 5. Photographic evidence from observations	16
Figure 6. Methodology toolkit for the waste-tourism system	22

List of Tables

Table 1. Interview questions	4
Table 2. Observations of littering practices, accumulations of waste materials, and waste facilities	6
Table 3. Perceptions of tourism impacts (n=57)	8
Table 4. Responses on waste facilities on work setting (n=57)	9
Table 5. Perceptions of tourism as a waste-generating sector (n=57)	9
Table 6. Perceptions of tourist littering practices (n=57)	10
Table 7. Source/type matrix for inputs beach litter reported during focus groups	12
Table 8. Observation descriptions by location	13
Table 9. Limitations of and alternatives to proposed criteria for MCDA	20
Table 10. MCDA for littering policy implementation	21

Table of Contents

Acknowledgements	iii
Abstract	iv
List of Figures	v
List of Tables	v
1. Introduction	1
2. Methods	
2.1. Study area	2
2.2. Interviews	3
2.3. Focus group	5
2.4. Observational data collection	5
2.5. Interpretation of results	7
2.6. Policy options to reduce marine littering	7
3. Results	
3.1. Interviews	8
3.2. Focus group	11
3.3. Observational data collection	12
4. Discussion	
4.1. Push factors towards beach/marine littering	17
4.2. Policy options to reduce marine littering	19
4.3. Constraints & Opportunities for future research	21
5. Conclusions	22
Literature Cited	23

1. Introduction

Plastic debris is amongst the most documented beach litter worldwide (Derraik 2002). Plastics have existed for just over a century and their great versatility and mechanical properties have made them affordable, durable, and good quality materials that can be found in every man-made and natural environment (O'Hara et al. 1988; Leite et al. 2014; Vegter et al. 2014). This is especially true in East Africa where, on one hand, the introduction of plastic proved beneficial by relieving local communities from carrying heavy rock-made containers to transport water, while on the other, it fostered the transition from local food markets towards supermarkets with high packaging content (Jambeck et al. 2018). The increase in the use of single-use plastics, such as water bottles, food wrapping, and bags, has led the way to overconsumption and persistence of plastic materials in local environments.

This study explores how the expansion of tourism brought about the emergence of ocean plastic pollution as an environmental hazard to Zanzibar's local environments and how this challenge is perceived by local stakeholders. This is a baseline study that investigates the presence of plastic debris on tourism beaches in Zanzibar, Tanzania and is based on field work that took place over the months of June and July, 2018. The main goals of the study are to explore the provenience and type of beach accumulations of plastics waste and propose policy tools to reduce marine littering based on observed and reported behaviors. For the purpose of this study, interviews and focus groups were conducted with stakeholders employed in the waste and tourism industries. Also, observational data on marine littering were obtained at four of the main cultural and ecotourism sites on the island of Unguja in the Zanzibar archipelago, located about 30 km off the Eastern coast of Tanzania.

Zanzibar is facing environmental challenges, including those related to poor management of solid waste, due to inability of local infrastructures and services to adapt to urban transformations. Contributing factors are rapid urban expansion and population growth on the island. These factors hindered the ability of local communities to develop efficient solid waste management systems and implement recycling activities (Yhdego 1995; Abdurasoul & Bakari 2016; Jambeck et al. 2018). In addition to urbanization, the island underwent a ten-time increase in the number of tourism activities over the past 30 years (Sharpley & Ussi 2014). Increasing expansion of the sector is underway and even more tourists are projected to visit the island in the near future. For instance, Zanzibar received 160,083 tourists in the first quarter of 2018, showing an increment of 21.8% when compared to the same period in 2017 (Zanzibar Commission for Tourism 2018).

The tourism industry in Zanzibar consists of small locally-owned activities and large foreign-owned tourism attractions. In 2015, the island was home to 376 tourism infrastructures, including hotels and guesthouses, equivalent to over 15,000 bed-spaces (Sharpley & Ussi 2014). Unprecedented growth of the tourism industry brought about an enormous increase in waste generation that shifted from organic materials to recyclables and hazardous waste derived from large tourism enterprises (Gössling 2002; Lange 2015). Yet, the input accumulations of plastic materials generated by these sectors remained unsurveyed.

Zanzibar produces over 92,000 metric tons of waste every year. Only 30% of the total amount of waste is handled by the Zanzibar Municipal Council and the remaining 70% is illegally dumped on streets, beaches, and green areas (Biubwa et al. 2014). To supplement municipal services, Zanrec Plastics Ltd, a Swedish-owned private company, is the only non-municipal actor in the waste management business. Since its foundation in 2009, the company has supplied recycling services, and in particular plastics recycling, by collecting waste from large tourism activities. However, hotels and resorts remain reluctant to subscribe contracts with Zanrec and less than 60 activities have partnered with it over the past 10 years (Blomstrand & Hagström 2014). Solid waste in Zanzibar is predominantly composed of organic waste, in fact approximately 80% of waste materials are biodegradable and compostable. The second largest

component of solid waste is plastics in the form of food packaging, plastic bags and wrappings, water and soft drink bottles, and single-use containers (Biubwa et al. 2014).

Plastic pollution originates from land and is discharged into the ocean when plastic products reach the final stage of their life cycle (Jambeck et al. 2015). Of the total amount of plastics produced in Zanzibar, only approximately 100 kg are collected and recycled by Zanrec every week. This is equivalent to only 9% of all plastics waste generated by hotels. An unquantified amount is dispersed in the environment and coastal waters where it may persist for centuries (McIlgorm et al. 2011; Blomstrand and Hagström 2014; Van Sebille et al. 2015). A recent study estimated that the African continent as a whole discharged approximately 4.4 million metric tons into the ocean in 2010, and these estimates could raise to 10.5 million metric tons in 2025 (Jambeck et al. 2015; Jambeck et al. 2018). While it has been suggested that, by 2050, plastic will outnumber fish by weight worldwide (Ellen MacArthur Foundation 2017), there are currently no comprehensive estimates of the amount of plastic debris and their future projections on small islands like Zanzibar.

When waste makes its way to the ocean, it jeopardizes the health and subsistence of marine ecosystems. The most documented effects of floating plastic debris on life below water include ingestion, entanglement, and chemical contamination. When plastic breaks down into smaller pieces, and especially when it fragments into infinitesimal particles termed microplastics (<5 mm), it can be ingested by a wider variety of organisms (Cózar et al. 2014; Zaho et al. 2015). Buoyant plastic particles are also associated with degradation of coral reefs and disease on microhabitats and macroinvertebrates that live in reef areas (Lamb et al. 2018).

In addition to the effects to the marine ecosystem, marine littering causes serious economic damages by affecting a wide range of natural environments that are considered primary ecotourism attractions, as is the case for Zanzibar. Plastic pollution has several negative effects on local economies by causing a decrease in the number of tourists and lost tourism revenues due to marine debris (Jang et al., 2014). It can impoverish local economies by reducing tourism development, damaging economic activities, and threatening private investments in hotels and tourism infrastructures (McIlgorm et al., 2011). Especially, coastal-dependent activities such as commercial and sport fishing, snorkeling, diving, and ocean expeditions are predicted to see rapid declines if actions are not taken to cope with ocean plastic pollution (Mohammed 2002; Staehr et al. 2018).

Until recently, little consideration has been given to identifying the causes of floating plastics in the world's oceans or determining the extent of debris accumulations in response to tourism expansion.

While it is known that marine pollution detrimentally affects the tourism industry (e.g. Mohammed 2002; Eriksen et al. 2013; Biubwa et al. 2014; Jang et al. 2014), its total contribution to environmental degradation is still an open question, particularly in small islands that heavily rely on tourism incomes. Hence the dual value of this initial inquiry into the Zanzibar context, a unique and world famous tourist site that can be a crucible for exploring solutions to the challenges at manageable scale.

This study investigates the waste-tourism system combining perceptions of tourism growth and its implications for the island's environment, in terms of waste production, with quantitative data on accumulations of waste, and in particular plastic materials, from the tourism sector.

2. Methods

2.1. Study area

Four sites on Unguja island were chosen for this study to understand the interconnections between the expansion of tourism in Zanzibar as a consumption sector and the availability of infrastructures to manage solid waste. These locations represent areas that are broadly accepted

within definitions of ecotourism and cultural tourism (e.g. TIES 2018; Tanzania Cultural Tourism Programme 2018). One is located in Stone Town which is designated as a UNESCO’s World Heritage Site (Figure 1). Two are located in the coastal areas of Nungwi and Uroa, on the Eastern coast of the island--well known for their tourism attractions. The fourth, Fumba, is a fishing village located in the biggest reef area of the island and famous for snorkeling and diving tours. To gather data on management of solid waste and emergence of marine plastic pollution in coastal areas, we conducted interviews and focus groups with local and foreign stakeholders and made direct observations of littering practices. Being exploratory, this study covers a diverse range of topics including perception of the impacts of the tourism sector in addition to waste production.



Figure 1. Map of Zanzibar Archipelago (left) and Unguja island including study areas (right).

2.2. Interviews

Structured interviews were conducted at each of the four study sites for a 5-week period over the months of June and July in 2018. This period enabled inquiry into the production and management of solid waste during high tourism season. The interviews consisted of 10 open-ended questions with some variations depending on the sector in which respondents were employed at the time of the survey. These were to assess (i) perception of tourism benefits and impacts on the local environment, (ii) waste facilities on work setting, (iii) perception of tourism as a sector that generates waste, and in particular plastic materials, and (iv) tourist littering practices (Table 1). Questions were asked in English and Italian by the interviewer, while a translator facilitated the process for interviews with Swahili-speakers. A total of 57 participants were selected amongst Zanzibaris aged 18 or older using snowball and purposive sampling (Goodman 1961; Biernacki & Waldorf 1981; Palys 2008) to address the possibility that selected interviewees were familiar with the topic based on their employment sector. Interviewees

constituted a reasonable sample of individuals working in the tourism or waste sector specifically which resulted in a satisfactory degree of diversity in the survey responses.

Table 1. Interview questions.

Perception of tourism benefits and impacts on the local environment
Q1. What does “tourism” mean to you?
Q2. What are the main benefits of tourism?
Waste facilities on work setting
Q3. Do you manage waste at work?
Q4. Do you recycle any materials? Which ones?
Q5. Do you store waste at work? Where?
Perception of tourism as a sector that generates waste
Q6. Do you think that tourism activities contribute to generating more waste?
Q7. Has plastic waste increased with tourism?
Tourist littering practices
Q8. Are tourists respectful of the local environment?
Q9. Do you think that tourists dispose of their waste into the ocean?
Q10. Have you seen any plastics waste in the ocean?

Response categorization. Interview responses were categorized in three groups based on their employment status at the time of the survey and position they occupied. The first category included 9 interviewees that were employed at large tourism activities, including staff, human resources coordinators, managers of hotels and resorts, and restaurant owners. Category two included 22 interviewees amongst owners of small gift and handicraft shops, tour guides, and drivers. Category three included 26 interviewees who worked for the municipal waste sector including street sweepers and cleaners and at dumping sites, beach cleaners, and officers from the municipal waste management department, as well as project managers from Zanrec.

Response coding. While the majority of questions entailed Yes/No answers to which respondents spontaneously provided some additional details as reported in results, the questions Q1, Q2, Q4, and Q5 followed the open-end format. For these questions, we coded answers as follows. As per Q1 and Q2, answers related to the meaning of tourism and its benefits were categorized in “income” or “other drivers” because words related to income (e.g. “money,” “economic benefits,” and “economic growth”) appeared to be the most common answer amongst interviewees. In the case of Q4, where the second part of the question included an open-end answer, we categorized and reported results for the recycled materials in: plastics, paper, glass, metal, and textile, based on answers. Based on the answers to Q5, we categorized waste storage facilities in: trash cans, street box, large containers (which is a common term to refer to waste transfer stations), and dumpsters.

2.3. Focus group

We conducted one focus group in Stone Town in July, 2018 with 19 participants recruited among members of an Italian community, which is one of the largest immigrant group on the island. This community was established in the 1990s and it has greatly contributed to the Zanzibari economy by investing in development of the tourism infrastructure and trade of local products on international markets. The goal of selecting a community in particular was to facilitate openness of the discussion about environmental topics within a demographically homogeneous group (Trettin & Musham 2000). Selecting this community in particular supported the possibility that individuals, who are familiar with solid waste management and recycling models in their home country, might be able to speak about the quality of waste management practices. The interviewer familiarity with the Italian language and culture facilitated the process.

During a 3-hour meeting, participants were asked to engage in group discussions to evaluate the quality and functioning of locally available waste management efforts. Topics addressed covered a range of issues including: (i) cultural barriers to proper management of solid waste, (ii) local-based initiatives to manage solid waste, (iii) accessibility to information on the impacts of plastic pollution, and (iv) source and type of marine litter.

2.4. Observational data collection

Observation data were obtained during a 5-week period in June and July, 2018 to evaluate environmental behaviors related to production and management of waste materials and also presence of plastic debris in the four tourism sites: Stone Town, Nungwi, Uroa, and Fumba (Figure 1). In order to select observation locations, we obtained information from beach-hotel staff on availability, accessibility, and conditions (such as type and quality, frequency of collection activities, and maintenance status) of waste disposal facilities in each site. Data collection methods are reported in Table 2. A GPS-based tracking system was used to record geospatial information from trash photographic data and to build a geo-referenced, waste pollution map of the four main sites surveyed.

Littering practices. Littering behaviors were assessed on tourism beaches and in proximity to reef areas in Stone Town and Fumba. Observations were recorded in Stone Town over a 19-day period for a total duration of 57 hours. Data consisted of frequency of use of trash cans or other waste collection points to dispose of food wrappings, water bottles, and cigarettes. In Fumba, observations were recorded over one day for a duration of 8 hours. Data consisted of disposal of water bottles and cigarettes during a boat excursion. Littering practices in both areas were recorded using photographic evidence and field notes.

Source, amount & type, and items of waste materials. Accumulations of waste, and specifically plastic materials, on tourism sites were assessed during cultural and ecotourism excursions in Stone Town, Nungwi, and Uroa. Source, size, and type of waste accumulations were recorded using geospatial reference and photographic evidence. Data were collected in Stone Town over a 6-day period between 10:00 am and 12:00 pm each day; in Nungwi data were collected over a 6-day period, between 5:00 pm and 7:00 pm; and in Uroa over a 6-day period between 5:00 pm and 7:00 pm.

Observations of waste materials at sea were of readily visible plastic debris classified respectively as macroplastics (20-100 mm) and megaplastics (>100 mm) (Zaho et al. 2015). Data collected consisted of an estimate of visual coverage of buoyant plastic debris including size and type of materials observed in superficial waters. Plastics at sea were assessed during two boat trips of a duration of 4 hours each. Trips departed from Stone Town and Fumba to visit areas around coral reefs covering a distance of about 10 km (Figure 1).

Number, location, type, and conditions of waste facilities. We identified the waste disposal facilities in proximity to tourism beaches and hotels (selected hotels in the two sites were representative of large-size facilities hosting 200 guests at their full capacity). Observations recorded number of trash cans, their location, type, and assessed their conditions (empty/full and frequency of emptying). We documented these observations using photographic evidence. Data were collected over two days in Stone Town, Nungwi, and Uroa for a total duration of 6 hours in each place.

Table 2. Observation data collection methods for littering practices, accumulations of waste materials, and waste facilities.

Observation site	Data collected	Method	Date	Number of days	Total hours
Stone Town	Littering practices	Observation, fieldnotes	June 16th - July 9th	19	57
	Source, amount & type, and items of waste materials	GPS tracking, photographic evidence	June 19th - June 24th	6	12
	Source, amount & type, and items of waste materials	Observation from boat, fieldnotes	June 28th	1	4
	Number, location, type, and conditions of waste facilities	GPS tracking, photographic evidence	July 3rd - July 4th	2	6
Nungwi	Source, amount & type, and items of waste materials	GPS tracking, photographic evidence	July 11th - July 16th	6	12
	Number, location, type, and conditions of waste facilities	GPS tracking, photographic evidence	July 12th - July 13th	2	6
Uroa	Source, amount & type, and items of waste materials	GPS tracking, photographic evidence	July 18th - July 23rd	6	12
	Number, location, type,	GPS tracking,	July 18th - July 19th	2	6

	and conditions of waste facilities	photographic evidence			
Fumba	Source, amount & type, and items of waste materials	Observation from boat, fieldnotes	July 22nd	1	4
	Source, amount & type, and items of waste materials	GPS tracking, photographic evidence	July 22nd	1	4
	Littering practices	Observation, fieldnotes	July 22nd	1	8

2.5. Interpretation of results

The study's results were interpreted and summarized using a closed loop diagram, a system-thinking tool that reports all variables of a complex system, such as waste-tourism, and describes the relations between such variables. For the purpose of this analysis, we imported in the software Stella (isee system) all variables from our findings that could influence the system in the form of push or pull factors towards accumulation of plastic debris on beach and marine areas in Zanzibar. Relationships between the identified variables were described as positive (+) when they were push factors towards beach/marine accumulations, or negative (-) when they were pull factors.

2.6. Policy options to reduce marine littering

This study can be used to implement policy for the waste-tourism system to limit marine littering in the short term. For this purpose, we used a Multi-Criteria Decision Analysis (MCDA) which is a decision support tool to address complex decision-making processes and establish preferences between options (Wang et al. 2009; Bertanza et al. 2016; Kumar et al. 2017; Makarichia et al. 2018). The MCDA allows to correlate objectives and related criteria to policy alternatives. This is especially useful when the process of making decisions involves multiple stakeholders with different interests, informed opinions, and needs, as is the case for the waste-tourism system. The use of this tool can also facilitate the evaluation and/or choice of a specific policy to reduce marine littering by comparing different options.

To implement the analysis, we defined a series of objectives based on the study's findings and within each objective we proposed criteria and evaluation questions. Criteria and evaluation questions are intended to guide users, such as policy makers or stakeholders from the waste sector and tourism sector, through the decision-making process. They also allow to evaluate specific needs and objectives in other sites of the island which might present different context conditions from those we analyzed.

3. Results

The present study merges qualitative data from interviews and focus group with quantitative data from observations to depict an accurate image of the waste-tourism system and all variables that might influence it in the form of push or pull factors towards accumulation of plastic debris on beach and marine areas in Zanzibar. All variables we identified are summarized in Figure 2.

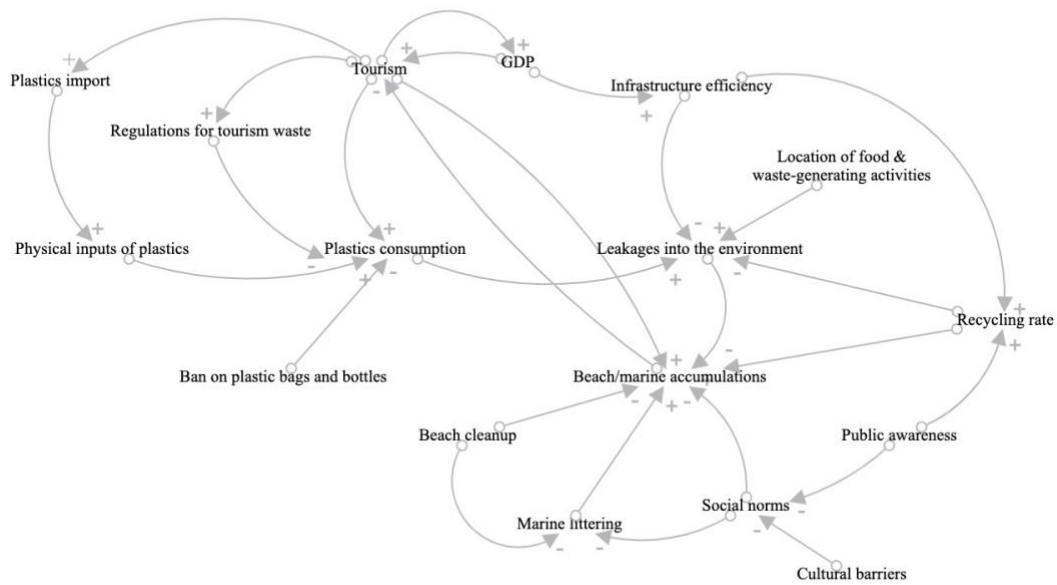


Figure 2. Closed loop diagram of beach and marine accumulations in Zanzibar (obtained from Stella).

3.1. Interviews

Perception of tourism benefits and impacts on the local environment. With respect to Q1, out of the 57 interviewees, 26.3% of respondents mentioned that tourism meant “income” to them, while 19.3% mentioned “other drivers” such as “cultural exchange” and “diversity.” Similarly, 40.3% responded to Q2 saying that “income” was the major benefit they experience from tourism growth, while only 3.5% reported “other drivers.” For example, some reported that interaction with tourists helped them to learn a new language. While it is not in the scope of this analysis to provide separated answers for different categories of respondents, it was noticed that the majority of those who answered “do not know” belonged to the waste management sector (category three). Results are reported in Table 3.

Table 3. Perceptions of tourism impacts (n=57).

	Income (%)	Other drivers (%)	Do not know (%)
Q1. Meaning of “tourism”	26.3	19.3	54.4
Q2. Tourism benefits	40.3	3.5	56.1

Waste facilities on work setting. Results from questions Q3-Q5 did not show any difference between respondents from different categories, and in particular Q4 and Q5 were the questions who recorder the highest number of respondents amongst all groups (100.0% response rate). With regard to Q3, the majority of respondents, 63%, said that they managed waste on work setting, while only 7.0% did not managed their waste. Q4 addressed the waste materials that were recycled at work. Similar to the previous question, the majority of respondents, 57.9%, recycled waste, while 42.1% did not. Out of those who positively responded to this question, answers on recycled materials were coded and categorized in: plastics (34.0%), paper (27.0%), glass (2.0%), metal (18.0%), and textile (19.0%) (Figure 3). To Q5 on storage of waste at work, more than half of respondents, 54.4%, said that they stored waste, while 45.6% said they did

not. Out of those who positively responded to this question, we coded and categorized responses about post-consumption waste storage facilities in: trash cans (16.0%), street boxes (36.0%), large containers (13.0%), and dumpsters (35.0%) (Figure 4). Results are reported in Table 4.

Table 4. Responses on waste facilities on work setting (n=57).

	Yes (%)	No (%)	Do not know (%)
Q3. Manage waste at work	63.2	7.0	29.8
Q4. Recycle waste at work	57.9	42.1	0.0
Q5. Store waste at work	54.4	45.6	0.0

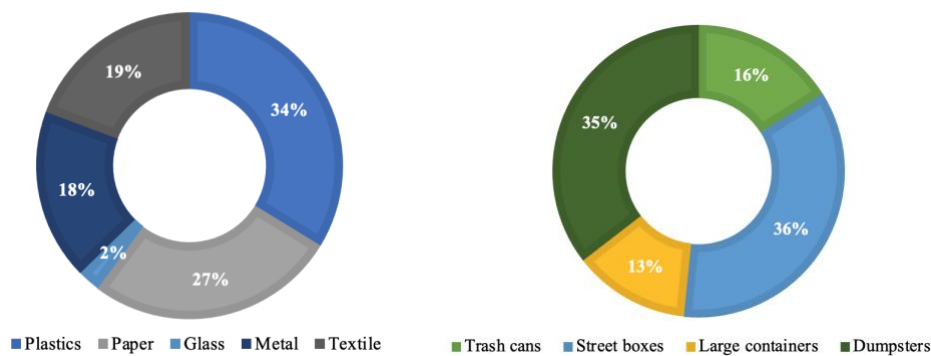


Figure 3. Waste materials recycled on work setting (left).

Figure 4. Waste storage facilities on work setting (right).

Perception of tourism as a sector that generates waste. With respect to Q6, half of the respondents, 50.9%, identified tourism as a waste generating sector as they reported greater accumulations of waste during high tourism season, and only 7.0% said that tourism did not generate more waste. In addition to responding to the question, some respondents from the waste management sector (category three) reported examples on how waste production changed during high tourism season. One respondent said that it “can even double,” and another one reported that during low tourism season he picked “5 carts every day. During high [tourism] season, [he picked] 7 carts [of waste].” For Q7, only 15.8% of respondents reported an increased generation of plastics waste during tourist high season, and 8.8% said that plastics waste did not increase. Amongst those who positively answered to this question, a hotel manager reported that “there are mainly plastic bottles [on beaches] and people here don’t drink bottled water because it’s expensive.” Results are reported in Table 5.

Table 5. Perceptions of tourism as a waste-generating sector (n=57).

	Yes (%)	No (%)	Do not know (%)
Q6. Tourism is a waste-generating sector	50.9	7.0	42.1
Q7. Plastic waste increases due to tourism	15.8	8.8	75.4

It is interesting to notice that, in addition to Yes/No answers, interviews with officers from the municipal waste management department and project managers at Zanrec (category three) expanded into the topic of inefficiency of regulations in the waste sector as a major barrier to providing efficient waste services. While the Zanzibar Municipal Council proposed a masterplan for implementation of waste collection services, they said that this proposal fails to provide regulations for all stakeholders (from private companies that could invest in the waste sector such as Zanrec, to activities generating waste such as hotels and food markets, to civic engagement). According to respondents, the waste management problem on the island is fivefold: (i) existing regulations on waste collection activities (e.g. areas covered, times and days of service provision, workers and equipment allocated to collection activities, and logistics operations) are only limited to the urban areas of Stone Town. (ii) Zanrec operates outside the area of operation of the Zanzibar Municipal Council and, therefore, its services are not subjected to municipal regulations. (iii) Zanrec reported lack of investments in its services by the Zanzibar Municipal Council and by the tourism sector which causes large areas to be excluded from all waste management services. (iv) The majority of hotels and resorts are not located in Stone Town and, therefore, are not within the area of operation of municipal regulations. (v) Finally, regulations are not integrated with educational programs or awareness campaigns to inform local communities and tourists on the importance of managing waste and preventing uncontrolled littering. Lack of civic engagement was suggested to be a major driver of uncontrolled littering in the environment, and especially in the marine environment.

Tourist littering practices. When asked about tourist littering practices, 42.1% of respondents said that tourists were respectful of the environment, and only 17.5% said they were not, with regard to Q8. Some respondents also said that it is Zanzibaris that are more likely to be not respectful of the environment. In fact, they can adopt a “throw everywhere culture” by making insufficient use of trash cans and other disposal facilities to dispose of waste materials. Using the words of a hotel manager: “people here have a throw-everywhere culture. They don’t care where they throw trash. Tourists would use dust bins but they can’t because there are no facilities.” Similar responses were recorded for Q9, where only 15.8% of respondents said that they had noticed tourists dumping trash into the ocean, and 21.1% said that tourists did not discharge waste into the ocean. In addition to his answer, a tour guide reported an example from his personal experience where “tourists throw everything in the sea from the boats. Waste comes from the boats.” With regard to plastics specifically as in Q10, 31.6% of respondents reported to have seen plastics at sea, and only 1.8% said that they had never noticed it. Amongst those who noticed buoyant plastic debris, one respondent commented: “I have seen bottles, plates, and glasses [cups] in the ocean. There are more when there are many tourists,” thereby suggesting that tourists were a plausible source of plastics at sea. Results are reported in Table 5.

Table 6. Perceptions of tourist littering practices (n=57).

	Yes (%)	No (%)	Do not know (%)
Q8. Tourists are respectful of the environment	42.1	17.5	40.4
Q9. Tourists discharge waste into the ocean	15.8	21.1	63.2
Q10. Evidence of plastics at sea	31.6	1.8	66.7

3.2. Focus group

Cultural barriers. During the focus group discussion, cultural differences with respect to lifestyles between Zanzibaris and immigrant communities were addressed. In particular, it was brought up that cultural barriers can serve as a push factor towards poor waste practices amongst Zanzibaris. For example, more than 90% of the population are Muslim and are not allowed to consume or enter in contact with alcohol in any way, and “glass-made bottles from alcoholic beverage remain uncollected on streets and beaches and broken glass fragments can cause harm to pedestrians or animals.” While it is clear from this example that consumption and production of alcohol bottles on the island remains low, this is an exemplar case of how cultural beliefs can affect the management of waste and drive to leakages of waste materials into the environment.

Local-based initiatives to manage solid waste. Focus group participants mentioned that beach cleanups constitute a key approach to managing solid waste on beaches and reported their experience. It was reported that, over the past decade, the Italian community has partnered with international and local NGOs, community-based organizations, and informal groups to establish the movement “Let’s Do It Zanzibar!” aimed at increasing awareness of waste issues as well as creating a sense of community based on ideas of care for the island’s marine environments. However, when asked about the contributions of such initiative to preventing marine littering, they said that “beach cleanups have only been limited to the shoreline and shore waters, while the high tide washes up residual litter.” In addition, “the frequency of these cleanups [once a month] is not sufficient to educate people, locals and tourists, about how to manage waste. We need help from the government to enforce an education system, otherwise alone we cannot provide education for everyone.”

Accessibility to information on the impacts of plastic pollution. Scarce access to information on the impacts of waste materials emerged as key driver of poor waste management on the island. Participants reported that, in Zanzibar, the ocean has been used as a convenient dumping site for decades based on the belief that “water washes up the waste that humans produce.” As one of the participants commented: “It is always been a common practice for Zanzibaris to throw their trash in the ocean. But in Zanzibar we have low and high tide cycles. So every village was meeting at night to dump their waste into the sea when the tide was low. But the next day, [after high tide has occurred] they would find more trash on the beach because water washed up trash from a village located northern to that one. Zanzibaris started thinking that the sea was bad and mad at them, and for this reason it was giving back the trash that they gave to its waters.”

Source and type of marine litter. Another topic for the focus group discussion was source and type of waste. Nearly all participants reported to have seen waste at sea and on all major tourism beaches. They said that the type of waste material was a predictor of their source. In particular, they reported six different types of waste: (i) plastics, (ii) paper, (iii) food waste, (iv) e-waste, (v) textile, and (vi) others (Table 7). According to participants, plastics waste was mainly produced by tourists, in the form of single-use bottles, packaging, bags, cups, plates, cutlery, and straws, and flip flops, and by large, foreigner-owned tourism activities, in the form of single-use bottles and packaging. Other source of plastics waste comes from local, small tourism infrastructures including bars, food distribution points, café, and shops, and Zanzibari households. Contrarily, these other types of waste materials were more common amongst local activities, households, and schools.

Table 7. Source/type matrix for inputs beach litter reported during focus groups.

	Tourists	Large, foreigner-owned tourism infrastructures	Local small tourism infrastructures	Zanzibari households	Schools
Plastics	Bottles, packaging, bags, cups, plates, cutlery, straws, flip flops	Bottles, packaging	Packaging, shore bank, bags, cups, plates, cutlery, straws	Flip flops, fishing net, packaging, tires	
Paper		Brochures			Books, sheets
Food waste		Animal products, veggies, fruit	Animal products, veggies, fruit	Veggies, fruit, fish	
E-waste				Batteries, electronics	
Textile				Clothes, shoes	
Others	Cigarettes, cans, glass bottles	Cans	Cans	Ceramics, glass bottles, medicines, construction materials	

3.3. Observational data collection

Results from visual data collection consisted of observation of (i) littering practices, (ii) source, amount, and type of waste materials in urban, beach, and marine areas, and (iii) number, location, type, and conditions of waste facilities (e.g. trash cans) at hotels and along the shoreline. Observations, divided by type of data collected and location, are reported in Table 8 and Figure 5.

Littering practices. Observations of littering practices were recorded on beach and marine areas. (i) The first set of observations took place in Forodhani Garden food market, located in Stone Town, where we observed waste management operations such as waste collection and street sweeping. Every day of observations, street sweepers from the waste management sector were observed discharging food wrapping and packaging from the market on the shoreline and into coastal waters. (ii) The second set of observations took place during a boat excursion that departed from Fumba and at each destination of the excursion. We observed that all waste

produced by tourists during navigation, such as plastic bottles and cigarettes, was kept into the boat and discharged at the arrival destination. Contrarily, tourists seemed to be less respectful once they reached the different destinations (islands). For example, after a meal at the main destination, tourists were seen dumping food leftovers and plastic utensils directly in the environment. A possible explanation for this is the absence of waste facilities at the meal location.

Source, amount & type, and items of waste materials. Waste accumulations were observed at all sites. (i) In Stone Town, visual data were collected in the urban area where we observed waste in proximity of stores, households, food activities, and hotels. The amount of waste varied by type, with plastics and construction materials accounting for the biggest accumulations. Other waste materials observed were aluminum, food waste, textile, glass, and cigarettes. Visual data were also collected at open sea during a boat excursion that departed from Stone Town, during which we observed primarily plastics waste originated by tourists and fishermen. (ii) Along the shoreline walk in Nungwi, we collected visual data on waste accumulations from hotel, tourists, food activities, fishermen, and stores. All observations consisted of plastic items. (iii) Along the shoreline walk in Uroa, we collected visual data from hotel, tourists, food activities, fishermen, stores, schools, households, and animals. Waste accumulations consisted of a broader variety of materials with plastics and glass being the largest by weight. Other waste materials observed were paper, animal waste, and e-waste. (iv) In Fumba, we collected visual data from tourists at open sea during the boat excursion, where all observations consisted of plastic items. We also collected visual data from tourists and stores at the main destination. Plastic materials accounted for the biggest accumulations of waste followed by food waste, cigarettes, and aluminum.

Number, location, type, and conditions of waste facilities. (i) Observations of existing waste facilities were recorded along the shoreline walk in Stone Town, where we counted 30 trash cans for unsegregated waste, regularly cleaned and emptied every day. (ii) At a selected hotel in Nungwi, we counted 20 trash cans for unsegregated waste, regularly cleaned and emptied every day. (iii) At a selected hotel in Uroa, we observed a variable number of trash cans because the containers were made of palm tree leaves and, therefore, could degrade at a different pace depending whether they were exposed to the sunlight, or closer to water. All trash cans observed served for unsegregated waste and were regularly cleaned and emptied every day.

Table 8. Observation descriptions by location.

Observation site	Data collected	Location	Description	Photos
Stone Town	Littering practices	Forodhani Garden food market	Street sweepers swept food wrapping and packaging from the market on the shoreline and into coastal waters.	(a)
	Source, amount & type, and items of waste materials	Urban area	<u>Source</u> : stores, households, food activities (e.g. bars, cafés, restaurants, vendors, markets), hotels. <u>Amount* & Type</u> : handful for aluminum/food, bagful for textile/glass/cigarettes, cartload for plastics/construction materials. <u>Items</u> : plastic plates, plastic cups, plastic cutlery, plastic straws, aluminum cans, water bottles, cigarettes, styrofoam	(b)

			containers, plastic bags and wrappings, food leftovers, construction materials, textile, accessories, and glass bottles.	
	Source, amount & type, and items of waste materials	Open sea	<u>Source</u> : tourists, fishermen. <u>Amount* & Type</u> : bagful for plastics. <u>Items</u> : water bottles, plastic plates, plastic cups, plastic straws, plastic cutlery, styrofoam food containers, fishing nets.	(c)
	Number, location, type, and conditions of waste facilities	Shoreline walkway	<u>Number</u> : 30 trash cans. <u>Location</u> : distanced 10 m from each other and aligned with palm trees and benches. <u>Type</u> : squared stone container sized 50 cm x 50 cm with a metal grid skeleton. <u>Conditions</u> : emptied every morning between 10:00 am and 12:00 pm.	(d)
Nungwi	Source, amount & type, and items of waste materials	Shoreline walkway	<u>Source</u> : hotel, tourists, food activities, fishermen, stores. <u>Amount* & Type</u> : bagful for plastics. <u>Items</u> : plastic bottles, plastic wrapping, plastic bags, fishing nets, flip flops.	(e)
	Number, location, type, and conditions of waste facilities	Hotel	<u>Number</u> : 20 trash cans. <u>Location</u> : lobby area (2), pool (1), pathways (11), and shoreline (6). <u>Type</u> : small-size (20 cm x 20 cm) wooden containers, sometimes equipped with ashtrays. <u>Conditions</u> : emptied every morning between 8:00 am and 12:00 pm.	(f)
Uroa	Source, amount & type, and items of waste materials	Shoreline walkway	<u>Source</u> : hotel, tourists, food activities, fishermen, stores, schools, households, animals. <u>Amount* & Type</u> : handful for paper/animal waste/e-waste, bagful for plastics/glass. <u>Item</u> : plastic bottles, plastic wrapping, plastic bags, fishing nets, non-food related containers (e.g. toothpaste and detergent containers), flip flops, tires, animal waste, textile, books, paper sheets, glass bottles, batteries, tires.	(g)
	Number, location, type, and conditions of waste facilities	Hotel	<u>Number</u> : variable. <u>Location</u> : lobby area, pool, pathways, and shoreline. <u>Type</u> : small-size (20 cm x 20 cm) containers made of palm tree leaves. <u>Conditions</u> : emptied every morning	(h)

			between 8:00 am and 12:00 pm and replaced every other day due to leaf deterioration.	
Fumba	Source, amount & type, and items of waste materials	Open sea	<u>Source</u> : tourists. <u>Amount* & Type</u> : handful for plastic. <u>Items</u> : plastic bottles, plastic plates, plastic cups, plastic straws, plastic cutlery, styrofoam containers, toothpaste tube, facial tissue wrapping.	(i)
	Source, amount & type, and items of waste materials	Islands	<u>Source</u> : tourists, stores. <u>Amount* & Type</u> : bagful for food waste/cigarettes/aluminum, cartload for plastics. <u>Items</u> : plastic plates, plastic cups, plastic cutlery, aluminum cans, water bottles, cigarettes, styrofoam containers, plastic bags and wrappings, food leftovers.	(j)
	Littering practices	Open sea and on islands	Tourists seemed to be mindful while travelling by boat (e.g. plastic bottles were used as ashtrays). Littering behaviors observed on islands showed uncontrolled dumping of solid waste post-consumption. In addition, absence of waste facilities on islands was recorded.	(k)

*Amount is defined as handful (it can fill up one hand), bagful (it can fill up a standard plastic bag), cartload (it can fill up a cart--0.5 square meter), or truck (amounts larger than cartload) (Source: World Cleanup).



(a)



(b)



(c)



(d)



(e)



(f)



(g)



(h)

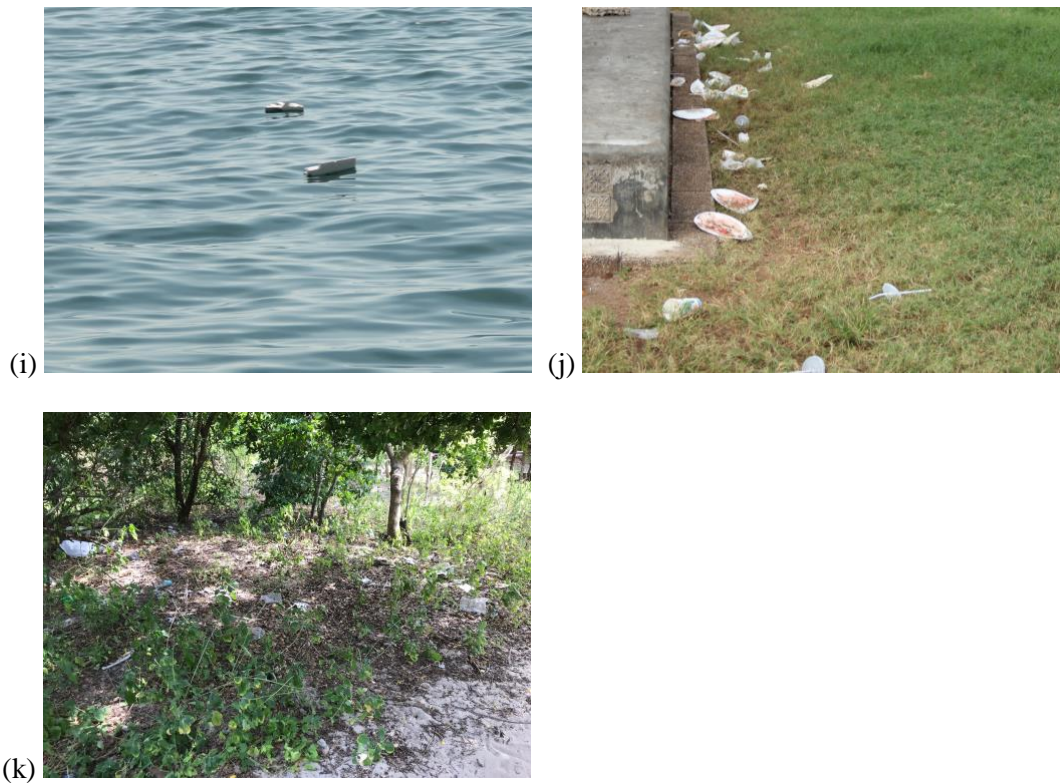


Figure 5. Photographic evidence from observations.

4. Discussion

4.1. Push factors towards beach/marine accumulations

A major objective of this study is to inform on the relationship between waste and tourism by investigating to which extent tourists and tourism infrastructures contribute to increased generation of plastics waste. This is the third study to explore the detrimental impacts of marine plastic pollution on the Zanzibar tourism landscape. While the previous two studies (Staehr et al. 2018; O'Brien 2018) focused on stressors and environmental impacts on marine ecosystems, and amounts of plastic debris in the Stone Town Harbor area respectively, this study provides a baseline, exploratory analysis of perceptions of waste and tourism and their correlation. All studies find that plastics waste is a major contributor to beach and marine litter by weight and lack of waste regulations for the tourism sector can lead to deterioration of the Zanzibar's marine environment.

Tourism: a waste-generating sector. While primary literature widely explores the role of tourism as a waste-generating sector (e.g. Gössling 2002; Mohammed 2002; Eriksen et al. 2013; Biubwa et al. 2014; Jang et al. 2014; Lange 2015; Staehr et al. 2018; O'Brien 2018), through this research we tested whether local communities perceptions aligned with the findings of previous studies or not. From both interviews and the focus group, tourism emerges as a waste-generating sector. For instance, workers in waste sector reported that they collect larger amounts of waste during high tourism season. Similarly, the focus group participants said that tourists and tourism infrastructures account for the majority of plastics waste produced on the island. Observations on all tourism sites match findings from qualitative data collection, as the most found type of waste materials is plastics waste generated from tourists and tourism infrastructures. Since tourism activities mainly take place on and nearby beaches, plastics waste can bear detrimental impacts on the marine environment.

Littering practices and cultural barriers. Our study indicates that waste makes its way into water primarily through direct disposal. Push factors towards leakages into the environment

and beach/marine accumulations in Zanzibar are: (i) location of food and waste-generating activities, (ii) recycling rate, (iii) social norms, and (iv) marine littering. (i) Proximity of food and other waste-generating activities to the coast, such as in the case of the Forodhani Garden food market, can have detrimental effects by accounting for large amounts of single-use plastics to leak into the ocean. In fact, it was witnessed that it is a common practice for street sweepers and waste pickers to discharge trash generated from those activities (e.g. single-use plastic plates, cups, cutlery, straws, and containers) into coastal waters. (ii) Second, low rates of plastics recycling are contributing factor to beach/marine accumulation of plastic debris. At present, Zanrec is the only company that recycles plastics on the island. Scarcity of facilities capable of sorting and, subsequently, recovering values from plastics and other recyclables causes such materials to leak into the environment. (iii) Third, our findings align with those from previous studies (e.g. Eagle et al. 2016) on how social norms and observation of peer behaviors can affect littering practices. From interviews, circulation of the so-called “throw everywhere culture” emerges as a push factor towards beach/marine accumulation, as well as it reduces potential for recovery and recycling of plastic materials. Uncontrolled dumping of waste seems to have always been a problem amongst Zanzibaris, as our findings from the interviews and focus group demonstrate, and social norms can also be bolstered by cultural barriers. (iv) Four, while observations reported that trash cans on tourism sites are easily visible, located in accessible places, and emptied every morning, improper littering practices were pervasive. These include lack of segregation of waste at its source, discharge of waste into water during boat excursions, such as in the case of Stone Town, and uncontrolled littering on beaches by tourists and Zanzibaris, as observed at all observation sites.

Source, amount & type, and items of waste materials. While it is true that a variety of waste materials were reported by the focus group participants (plastics, paper, food waste, e-waste, textile, and others), similar to the two previous studies on marine pollution in Zanzibar (Staehr et al. 2018; O’Brien 2018), our findings demonstrate that plastic is the most common waste material on beaches. Source, amount, and type of waste materials vary from one observation site to another, but all observations reported a significant presence of single-use plastics, and in particular food packaging and utensils. It was reported during the focus group, as well as it was observed, that these plastic products originate mostly from tourists and large, foreigner-owned tourism infrastructures. Amounts of plastic products discarded on beach and marine areas range from handful to bagful, with some peaks in the urban area of Stone Town where we recorded cartload amounts of plastics waste. A possible explanation for this pattern is that Stone Town is home to a wide variety of tourism infrastructures and food activities which generate overproduction of waste locally. Finally, with regard to specific items of plastics waste, the most recorded are: bottles, cups, plates, cutlery, straw, wrapping and packaging, and food containers.

Waste facilities. From our observations, it emerges that waste facilities (e.g. trash cans) on tourism sites are visible, accessible, and well-functioning (for example they are emptied every day). We recorded that the current number of trash cans is sufficient to receive all waste materials produced locally during a 1-day period. However, it appears that poor use of these facilities causes major leakages of plastics waste into the environment. It was also observed that existing waste facilities can only receive unsegregated waste, thereby preventing the user from separating trash from recyclables and compost post-consumption. As a result, recyclables are considered purely waste causing loss of revenues from recovery and recycling of such materials.

Local-based initiatives to reduce marine littering. Qualitative data suggest evidence for the inefficiency of beach management through cleanups. While this approach has set a guiding framework to regulate the circulation of plastic materials in the marine environment, major system changes are needed to foster the transition towards plastic-free beaches. In fact, results from interviews, focus group, and observations show that an undefined amount of plastic debris accumulates on tourism beaches and ends up into coastal waters every day. Our findings show

that cleanups on Zanzibar beaches have failed to limit the problem and do not provide long-term solutions to controlling and preventing marine littering. One possible approach to enhance efficiency of beach cleanups can address enforcement of littering tax to sanction uncontrolled littering on beach and marine areas.

Waste regulations and policy options. Our interviews report that existing regulations fail to engage all stakeholders of the waste-tourism system. Therefore, waste produced by tourists and tourism infrastructures remains mostly unregulated and can account for uncontrolled disposal of such waste on beach and marine areas. Based on the findings reported in the previous paragraphs, we suggest three policy options to address uncontrolled waste disposal: (i) ban single-use plastics from beaches, (ii) littering tax, and (iii) waste segregation at source. We hypothesize that these three approaches could reduce the amount of plastics waste leaking into the environment on one hand, and generate revenues from recycling on the other by turning plastics waste into an economic opportunity (Maione 2016; Maione & Morello 2017).

4.2. Policy options to reduce marine littering

Through this study, the following emerged as critical objectives to be considered in the MCDA to reduce marine littering: (i) post-consumer waste management, (ii) stakeholder engagement, and (iii) management of waste facilities on/near beaches. Each objective entails multiple criteria and a proposed set of questions. Users can use these questions as a guideline approach to evaluate the importance of each objective in regard to local systems and framework conditions, efficiency of existing systems to manage waste materials at the end of their life, and understand the complexity of interactions between all stakeholders in the waste sector and tourism sector. In addition, we identified a variety of limitations of and alternative approaches to the proposed criteria, as reported in Table 9.

Post-consumer waste management. Poor management of solid waste materials at the end of their life cycle has been identified as a major driver of uncontrolled dumping in the natural and marine environment in Zanzibar. Proposed criteria and related evaluation questions are:

(i) Collection rates: How do collection rates vary between low/high tourism season? Are collection rates proportional to the amount of waste produced? How many tourism activities are served by collection systems? How much waste is generated per activity and how much of this amount is collected?

(ii) Potential for recycling (in particular of plastic materials): What type of materials are recycled? Are collected materials readily recyclable or are further steps needed? Is it possible to separate materials for recycling from non-recyclables? Are existing systems capable of receiving materials for recycling? Are existing technologies capable of recovering value from materials? Is there a market for recycled materials?

(iii) Reduced leakages into the environment: Are waste materials managed at the end of their life cycle? How do leaking rates vary between low/high tourism season? What are the most found materials in the marine environment in the two season? Are there leakages in the existing system (collection-transfer-disposal)?

Stakeholder engagement. Knowledge and information gaps of how municipal and tourism sectors manage waste internally lead to lack of system transparency and subsequent inability to propose sound solutions. Proposed criteria and related evaluation questions are:

(i) Relationship municipal-tourism waste sector: Who are all stakeholders of this relationship? How do they communicate? What are some potential communication strategies? Do all stakeholders access the same information? What are specific roles and responsibilities?

(ii) Civic engagement: Are local communities an integral part of the solution? What are potential barriers to their engagement? What is their relationship with other stakeholders? Do they have access to information? What can boost behavior changes in their littering practices?

Management of waste facilities on/near beaches. Observations show that while beaches are equipped with well-functioning waste collection points, little or no use of such facilities has

contributed to accumulation of plastic debris on and near beach areas. Proposed criteria and related evaluation questions are:

(i) Use of facilities: Who uses waste facilities? How and when are these facilities being used? What are their conditions? Are facilities accessible to users? Is it possible to implement separation of waste facilities (trash-recyclable-compost)?

(ii) Information on materials: Are users aware of where facilities are located? Are users aware of how to use the facilities? Are information on disposable materials disseminated and, if yes, how?

Table 9. Limitations of and alternatives to proposed criteria for MCDA.

			Limitations	Alternatives
Reduce marine littering	Post-consumer waste management	Collection rates	Lack of infrastructures; Increased waste from tourism	Improved sector efficiency; Private-public investments
		Potential for recycling	Organic/inorganic contamination; Lack of technologies	Feasibility study; Plastic as an economic resource
		Reduced leakages into the environment	Mismanagement of waste	Waste transfers monitoring
	Stakeholder engagement	Relationship municipal-tourism waste sector	Lack of SWM integration	Dialogue; Integrative waste strategies
		Civic engagement	Mistrust in government; Cultural barriers; Social norms	Awareness and education; Behavioral change
	Management of waste facilities on/near beaches	Use of facilities	Limited use	Survey of uses
		Information on materials	Lack of information	Informational interventions

Table 10 illustrates three strategy approaches that can be used alternatively or combined to reduce marine littering: (i) ban of single-use plastics from beaches, including ban of cups, cutlery, plates, straws, wrapping, and food containers from food distribution points (e.g. café, bars, kiosks, food markets, and vendors) on or nearby beach areas, (ii) imposition of a littering tax to encourage more responsible littering practices and sanctions for disposal of waste materials on beaches and into water, and (iii) waste segregation at its source, including households and tourism activities, to allow for increased collection and recycling rates, boosting opportunities for recovering economic value from waste materials. We scored policy alternatives for their potential in relation to the selected criteria.

Table 10. MCDA for littering policy implementation (score 1: positive impact on the criterion, score 0: no impact on the criterion*).

			Ban single-use plastics from beaches	Littering tax	Waste segregation at source
Reduce marine littering	Post-consumer waste management	Collection rates	1	1	1
		Potential for recycling	1	1	1
		Reduced leakages into the environment	1	1	0
	Stakeholder engagement	Relationship municipal-tourism waste sector	1	1	0
		Civic engagement	1	1	1
	Management of waste facilities on/near beaches	Use of facilities	0	1	1
		Information on materials	0	0	1

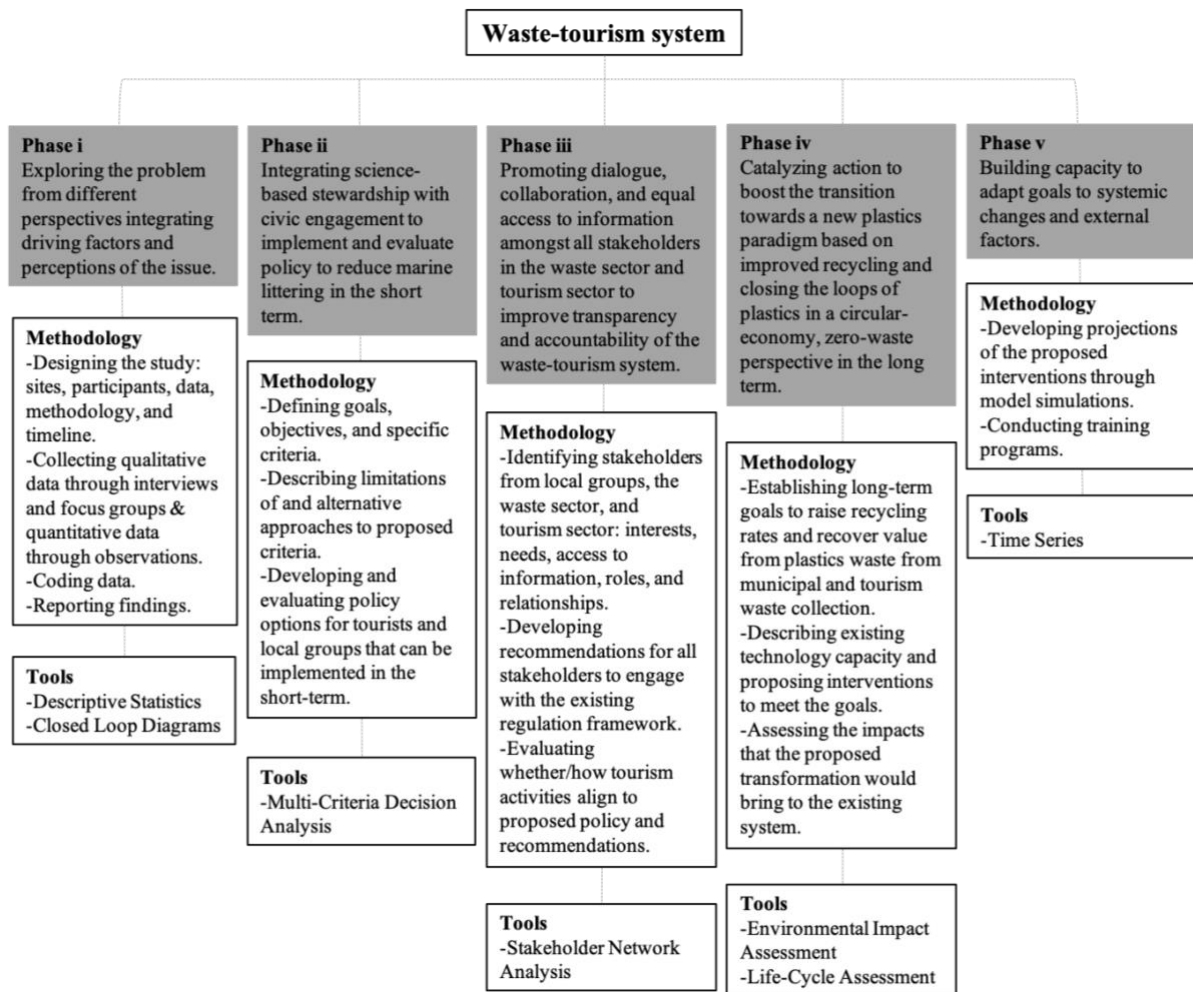
*We proposed a binary system to assess whether or not the policy options will bear an impact on the selected criterion. In MCDA, weighted scores are allocated based on a broader variety of factors that allows to choose the preferred option based on utility.

4.3. Constraints & Opportunities for future research

Time constraints accounted for methodology limitations. We recommend a fivefold approach to the study of the waste-tourism system, of which the present study only covers phase i and phase ii. As shown in Figure 6, the proposed approach consists of:

- (i) Exploring the problem from different perspectives integrating driving factors (quantitative data) and perceptions of the issue (qualitative data);
- (ii) Integrating science-based stewardship with civic engagement to implement and evaluate policy to reduce marine littering in the short term;
- (iii) Promoting dialogue, collaboration, and equal access to information amongst all stakeholders in the waste sector and tourism sector to improve transparency and accountability of the waste-tourism system;
- (iv) Catalyzing action to boost the transition towards a new plastics paradigm based on improved recycling and closing the loops of plastics in a circular-economy, zero-waste perspective in the long term;
- (v) Building capacity to adapt goals to systemic changes and external factors.

Figure 6. Methodology toolkit for the waste-tourism system.



5. Conclusions

This study explores the extent to which tourism expansion impacts on the production of waste, and in particular plastic materials, in Zanzibar, and it can be considered a pilot for small islands in developing countries with economies that heavily depend on tourism. As part of a broader research on accumulation of plastic debris on tourism sites, this work suggests a baseline approach to the study of marine plastic pollution within the waste-tourism system. Our analysis identifies as contributing factors towards beach/marine accumulations of plastic debris in Zanzibar a variety of variables ranging from improper littering practices, to inefficiency of existing regulations in the waste sector, cultural barriers and social norms, or scarce provision of recycling services on the island. Within this analysis, tourism emerges as a transversal factor that accounts for the largest beach/marine accumulations by weight. A tentative explanation for the role that tourism plays is that the production of waste from the tourism sector remains unregulated and unsurveyed. While examination of the problem in the present analysis is limited by a knowledge gap of scale and distribution of marine plastic pollution, future studies should measure the amounts of plastics waste observed, the types of plastic materials, and their potential index of dispersion in the marine environment. A broader investigation of the problem can foster the implementation of sound changes to the existing waste-tourism system, including behavioral, regulations, and policy changes.

Literature Cited

- Abdulrasoul, A. A., & Bakari, S. S. (2016). Challenges and Problems of Solid Waste Management in Three Main Markets in Zanzibar. *Advances in Recycling Waste Management*, 1(2), 1-9.
- Bertanza, G., Baroni, P., & Canato, M. (2016). Ranking sewage sludge management strategies by means of Decision Support Systems: a case study. *Resource, Conservation and Recycling*, 110, 1-15.
- Biernacki, P., & Waldorf, D. (1981). Snowball sampling: Problems and techniques of chain referral sampling. *Sociological methods & research*, 10(2), 141-163.
- Biubwa, A., Sharifah, N., S., I., & Irniza, R. (2014). Municipal solid waste management of Zanzibar: Current practice, the challenges and the future. *International Journal of Current Research and Academic Review*, 1(2014), 5-19.
- Blomstrand, E., & Silander Hagström, T. (2014). *Waste management and production systems; The case of Zanzibar*. Sverige: KTH.
- Cózar, A., Echevarría, F., González-Gordillo, J. I., Irigoien, X., Úbeda, B., Hernández-León, S., Palma, A. T., Navarro, S., García-de-Lomas, J., Ruiz, A., Fernández-de-Puelles, M. L., & Duarte, M. D. (2014). Plastic debris in the open ocean. *Proceedings of the National Academy of Sciences*, 111(28), 10239-10244.
- Derraik, J. G. (2002). The pollution of the marine environment by plastic debris: a review. *Marine pollution bulletin*, 44(9), 842-852.
- Ellen MacArthur Foundation (2017). *The New Plastic Economy: Rethinking the future of plastics & catalysing action*.
- Eriksen, M., Maximenko, N., Thiel, M., Cummins, A., Lattin, G., Wilson, S., Hafner, J., Zellers, A., & Rifman, S. (2013). Plastic pollution in the South Pacific subtropical gyre. *Marine pollution bulletin*, 68(1-2), 71-76.
- Goodman, L. A. (1961). Snowball sampling. *The annals of mathematical statistics*, 148-170.
- Gössling, S. (2002). Human–environmental relations with tourism. *Annals of Tourism Research*, 29(2), 539-556.
- Jambeck, J. R., Geyer, R., Wilcox, C., Siegler, T. R., Perryman, M., Andrady, A., Ramani, N., & Law, K. L. (2015). Plastic waste inputs from land into the ocean. *Science*, 347(6223), 768-771.
- Jambeck, J., Hardesty, B. D., Brooks, A. L., Friend, T., Teleki, K., Fabres, J., Beaudoin, Y., Bamba, A., Francis, J., Ribbink, A.J. & Baleta, T. (2018). Challenges and emerging solutions to the land-based plastic waste issue in Africa. *Marine Policy*, 96, 256-263.
- Jang, Y. C., Hong, S., Lee, J., Lee, M. J., & Shim, W. J. (2014). Estimation of lost tourism revenue in Geoje Island from the 2011 marine debris pollution event in South Korea. *Marine Pollution Bulletin*, 81(1), 49-54.
- Kumar, A., Sah, B., Singh, A. R., Deng, Y., He, X., Kumar, P., & Bansal, R. C. (2017). A review of multi criteria decision making (MCDM) towards sustainable renewable energy development. *Renewable and Sustainable Energy Reviews*, 69, 596-609.

- Lamb, J. B., Willis, B. L., Fiorenza, E. A., Couch, C. S., Howard, R., Rader, D. N., True, J. D., Kelly, L. A., Ahamd, A., Jompa, J. & Harvell, C. D. (2018). Plastic waste associated with disease on coral reefs. *Science*, 359(6374), 460-462.
- Lange, G. M. (2015). Tourism in Zanzibar: Incentives for sustainable management of the coastal environment. *Ecosystem Services*, 11, 5-11.
- Leite, A. S., Santos, L. L., Costa, Y., & Hatje, V. (2014). Influence of proximity to an urban center in the pattern of contamination by marine debris. *Marine pollution bulletin*, 81(1), 242-247.
- Maione, C. (2016). *Reducing the Urban Metabolism of Informal Settlements. Implementing a community-based waste management in Kibera, Nairobi*. Milan: Politecnico di Milano.
- Maione, C., & Morello, E. (2017). New Life to Plastic: Reducing the Consumption of Plastic Materials and Turning Waste into Opportunity in African Informal Settlements. *Journal of Business and Economics*, 11(8), 941-951.
- Makarichi, L., Techato, K. A., & Jutidamrongphan, W. (2018). Material flow analysis as a support tool for multi-criteria analysis in solid waste management decision-making. *Resources, Conservation and Recycling*, 139, 351-365.
- McIlgorm, A., Campbell, H. F., & Rule, M. J. (2011). The economic cost and control of marine debris damage in the Asia-Pacific region. *Ocean & Coastal Management*, 54(9), 643-651.
- Mohammed, S. M. (2002). Pollution management in Zanzibar: the need for a new approach. *Ocean & coastal management*, 45(4-5), 301-311. Van
- O'Brien, C. J. (2018). Let's Talk Takataka: Impacts of Plastic in the Stone Town Harbor Area, Zanzibar. *Independent Study Project (ISP) Collection*. 2869.
- O'Hara, K. J., & others (1988). *A citizen's guide to plastics in the ocean: more than a litter problem*. Washington DC: Center for Marine Conservation.
- Palys, T. (2008). Purposive sampling. *The Sage encyclopedia of qualitative research methods*, 2(1), 697-8.
- Sharpley, R., & Ussi, M. (2014). Tourism and governance in small island developing states (SIDS): the case of Zanzibar. *International Journal of Tourism Research*, 16(1), 87-96.
- Staehr, P. A., Sheikh, M., Rashid, R., Ussi, A., Suleiman, M., Kloiber, U., Dahl, K., Tairova, Z., Strand, J., Kuguru, B. & Muhando, C. (2018). Managing human pressures to restore ecosystem health of zanzibar coastal waters. *Journal Aquaculture & Marine Biology*, 7(2), 59-70.
- Tanzania Cultural Tourism Programme (accessed February 2018): <http://www.tanzaniaculturaltourism.com/index.html>
- TIES (accessed February 2018): <https://ecotourism.org/>
- Trettin, L., & Musham, C. (2000). Is trust a realistic goal of environmental risk communication? *Environment and behavior*, 32(3), 410-426.

Van Sebille, E., Wilcox, C., Lebreton, L., Maximenko, N., Hardesty, B. D., Van Franeker, J. A., Eriksen, M., Siegel, D., Galgani, F. & Law, K. L. (2015). A global inventory of small floating plastic debris. *Environmental Research Letters*, 10(12), 124006.

Vegter, A. C., Barletta, M., Beck, C., Borrero, J., Burton, H., Campbell, M. L., Costa, M. F., Eriksen, M., Eriksson, C., Estrades, A., Gilardi, K. V. K., Hardesty, B. D., Ivar do Sul, J. A., Lavers, J. L., Lazar, B., Lebreton, L., Nichols, W. J., Ribic, C. A., Ryan, P. G., Schuyler, Q. A., Smith, S. D. A., Takada, H., Townsend, K. A., Wabnitz, C. C. C., Wilcox, C., Young, L. C., & Hamann, M. (2014). Global research priorities to mitigate plastic pollution impacts on marine wildlife. *Endangered Species Research*, 25(3), 225-247.

Wang, J. J., Jing, Y. Y., Zhang, C. F., & Zhao, J. H. (2009). Review on multi-criteria decision analysis aid in sustainable energy decision-making. *Renewable and sustainable energy reviews*, 13(9), 2263-2278.

Yhdego, M. (1995). Urban solid waste management in Tanzania Issues, concepts and challenges. *Resources, Conservation and Recycling*, 14(1), 1-10.

Zanzibar Commission for Tourism (2018). *Tourism Statistical Release April-2018*. Zanzibar: Office of the Chief Government Statistician.

Zhao, S., Zhu, L., & Li, D. (2015). Characterization of small plastic debris on tourism beaches around the South China Sea. *Regional studies in marine science*, 1, 55-62.