



NAMIBIA UNIVERSITY
OF SCIENCE AND TECHNOLOGY



Department of Agriculture and Natural Resources Sciences
Bachelor of Natural Resource Management (Nature Conservation)
Work Integrated Learning (Project Report)

Investigation and comparison of the type, amount and possible source of litter along two urban sections of mixed sand and rocky beach used for different purposes, in Swakopmund, Namibia.



Natanael Hangula
215082648
Mentor: Viktoria Keding
Tutor: Shirley Bethune
Date: 15/06/2018

Table of Contents

Abstract	1
1. Introduction	1
1.1 Study Area	2
2. Aims and Objectives	3
2.1 Research Questions	3
2.2 Objectives	4
2.3 Hypotheses	4
3. Methods and Materials	5
3.1 Determination and assessment of the type and amount of litter found at each site, both during the week and after weekends	5
3.2 Observations of the activities of people at each study site, both during the week and at weekends	6
3.3 Assessment of the possible source of the different kinds of litter found at each site	6
3.4 Determination to see if there was any link between differences for litter collected during the week and after weekends and the human activity at both sites.	6
3.5 Observations of coastal birds found along the coast and seen at these sites, to determine if the litter was likely to pose any threat to them.	6
3.6 Data analysis	6
4. Results	7
4.1 A) The amount and assessment of each type of litter found at each study site both during weekends and week-days.	7
4.1. B) Comparison of litter collected at sites A & B.	10
4.2 Human activities	11
4.3 The possible source of litter found	12
4.4 Comparison of the two data sets collected in 4.1 and 4.2	12
5. Discussion	14
5.1 Assessment of amounts and types of litter found during the survey and comparison between sites	14
5.2 Human activities at both sites and how they relate to litter	14
5.3 The source of the litter found	16
5.4 Sea bird observations	16
5.5 Usefulness of the information gained to the Municipality of Swakopmund and NaDEET	17
6. Conclusion and Recommendations	17
7. Acknowledgements	17
8. References	18

Investigation and comparison of the type, amount and possible source of litter, along two urban sections of mixed sand and rocky beach used for different purposes, in Swakopmund, Namibia.

Abstract

Swakopmund is a coastal town in the Erongo Region, in western Namibia in the Namib Desert and it is affected by a diversity of anthropogenic pressures and is further expected to suffer from the negative economic, environmental and social impacts of coastal litter. A total of 1113 litter items were collected from a total survey area of 5000m² over ten weeks. A huge proportion of the litter items collected were plastic items which made up 54% of all litter items collected during the entire survey. Direct deposition of litter items on the beaches by humans was identified as the main method of beach littering to this coastal environment. The results from this study concluded that poor local awareness and practical educational programmes can help reduce coastal litter.

1. Introduction

Coastal littering has become one of the environmental issues that the world is challenged with and concrete solutions need to be put in place to avoid the negative impacts that result from littering. Coastal littering does not only affect the surrounding areas like the beach but it also causes pollution in the ocean. Marine littering can be defined as, “any persistent manufactured or processed solid material which is discarded, disposed of, or abandoned in the marine and coastal environment” (Bergmann, Gutow and Klages, 2015). Coastal littering also poses a danger to coastal animals such as birds and turtles. In order to find solutions, investigations and studies need to be done.

This project carried out a 5 month investigation on littering along the beach zone of Swakopmund town at two sites used in different ways. The study was to investigate the type, amount and possible source of litter. As environmental educators, we have to link everything that surround us, the relationship and responsibility of all living creatures and what effects arise from human behaviour towards the entire ecosystem. This project was carried out to identify the different kinds of litter, the amount of each kind and the possible source of this litter. Thought was also given to what the possible impact this litter may have on the natural environment. This project also made us realise that we as human beings need to change our habits in order to reduce littering and reduce our impact on the environment. In the long run, if nothing is done to reduce pollution by litter, the world will be faced with serious environmental issues such as the increasing plastic debris in the ocean, polluted land will lose its value and the earth could become less productive, so changing the food and energy cycle in nature that all our plant and animal species depend on. Other effects will be on the economic sector where governments will be forced to spend huge amounts of money on cleaning up and enlarging land-fill sites to handle the solid waste we produce.

1.1 Study Area

The project was done at two separate beach sections in Swakopmund town. The two sections are both sandy beaches, with human-made rock embankments or gabions to protect the town from wave-action. Site A, shown in figure 1 extended, north 500m from the Jetty to the Mole at the Strand Hotel, where the main activities were tourist and residents walking along the beach. Site B, shown in figure 2 extended the some length (500m), and was situated between the new Platz am Meer shopping mall and just passed the Braai area, where the main activities were fishing, recreation (mainly braaing) and residents walking to and from the beach, often with food they had bought at the Mall.



Figure 1. Site A, The section between the Jetty and Strand Hotel

Source: Adapted Google Map

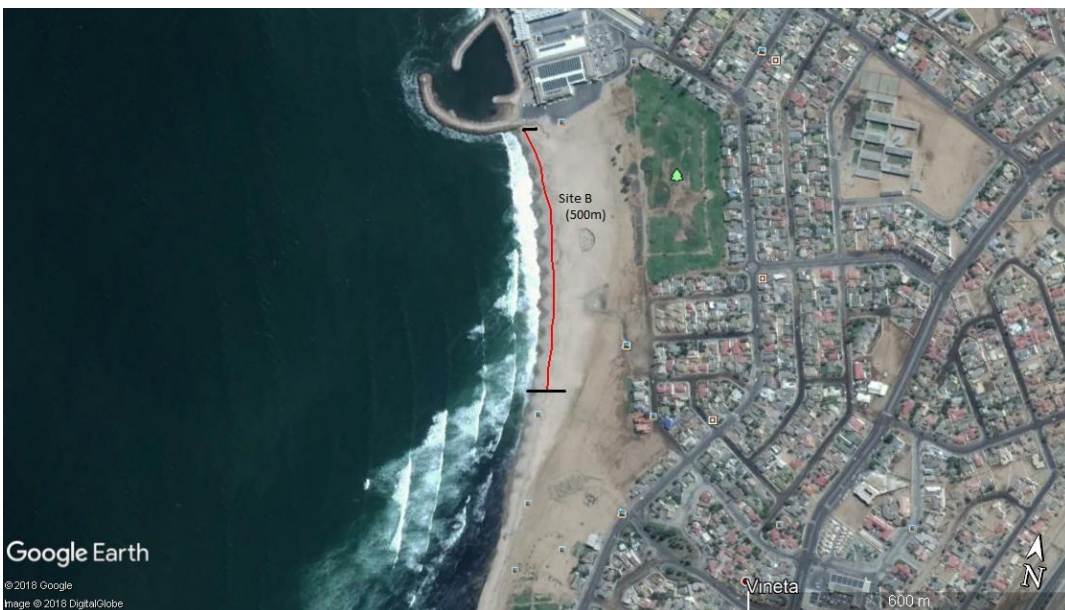


Figure 2. Site B, the section between Platz am Meer shopping mall and the south side of the braai area.

Source: adapted from Google Map

Although these study areas were subject to human influence, some marine animals and vegetation still occurred within the study area and the surroundings. The most often seen animals are coastal birds such as the Kelp gull (*Larus dominicanus*), Hartlaub's gull (*Larus hartlaubii*), Cape cormorant (*Phalacrocorax capensis*), Grey heron (*Ardea cinerea*), White-fronted plover (*Charadrius marginatus*) and the Common Whimbrel (*Numenius phaeopus*). Other birds such as Blacksmith lapwing (*Vanellus armatus*) and common Moorhen (*Gallinula chloropus*) and Kittlitz's plover (*Charadrius pusillus*) were seen at the Swakop River mouth. The birds seen were identified using Sinclair & Hockey, (2005). On rare occasions Cape fur Seals (*Arctocephalus pusillus*) were observed. As Swakopmund is a town most of its land is covered by buildings and other infrastructure, which means less vegetation. Most of the plants are garden or alien plants that are well adapted to the coastal environment such as mother-in-law's tongue (*Sansevieria trifasciata*), different roses (*Rosmarinus officinalis*), *Olea europaea* (olive trees) and pine trees. Indigenous species include plants like *Tamarix usneoides* that grows near the Swakop River mouth and *Sarcocornia perennis* (sapphire glasswort) which forms a dense mat at Swakop River mouth. These two plant species are well adapted to salinity (Branch GM, Griffiths M, Branch ML, & Beckley LE, 2007). The two main indigenous succulent shrubs found near the sea along the beaches were Pencil bush (*Arthroa leubnitziae*) and the Dollar bush (*Zygophyllum stapfii*), (Mannheimer & Curtis, 2009).

2. Aims and Objectives

The main aim of this study was to investigate and compare the type, amount and possible source of solid litter along the two sections of sand and rocky beach in Swakopmund. As mentioned in the section on the study area the two sections were used differently by the locals and visitors to the coastal town. This study also aimed to investigate if there was a difference in the litter found at the sites and if the amounts found were differently during the week and during weekends. Finally it aimed to see if there was any link between the amounts and kinds of litter found and the different activities.

2.1 Research Questions.

This Project was aimed to answer the following questions:

- ❖ What type and how much litter is found along the urban sections of the coast in Swakopmund?
- ❖ Is there any difference in the activities of people on the beach near the city centre and in the suburbs close to a mall, recreation and fishing area?
- ❖ Does the difference in activities influence the kind and amounts of litter found?
- ❖ Does the difference in activities explain the source of the litter and does the weather, particularly cold and tides, play a role in human activity and /or the dispersal of the litter?
- ❖ Are weekend activities different to week-day activities and how does this influence the type and amount of litter found after weekends and during the week?
- ❖ Can the results of this study be useful to the Municipality of Swakopmund to work out a more effective cleaning schedule?

2.2 Objectives

To answer these questions and to meet the aims the research, the following objectives were set:

1. To determine the type and amount of the litter found at each site, both during the week and after weekends.
2. To observe the activities of people at each study site, both during the week and during weekends.
3. To use this data together with weather records to try to assess the possible source of the different kinds of litter found at each site.
4. To use this data to observe if there are any differences between the litter found during the week and after weekends and link this to any differences in human activities at both sites.
5. To observe the coastal birds found along the coast and seen at these sites, to determine if the litter is likely to pose any threat to them.

It was hoped that information gained in this study could provide advice on what litter awareness is needed at the coast and how NaDEET could help and for designing a cleaning schedule that could be useful to the Municipality of Swakopmund.

2.3. Hypotheses

The two main hypotheses that were tested were therefore:

Hypothesis 1

- ❖ The Null Hypothesis: There is no significant difference in the amount of waste collected between the two sites based on the activities of people at each site.
- ❖ The Alternative Hypothesis: There is a significant difference in the amount of waste collected between the two sites based on the activities of people at each site.

Hypothesis 2

- ❖ The Null Hypothesis 2: There is no significant difference in the amount of waste collected after the weekends and during the week at each of the two sites.
- ❖ The Alternative Hypothesis 1: There is a significant difference in the amount of waste collected after the weekends and during the week at each of the two sites.

3. Methods and Materials

The data collection for this study was done during my internship at the NaDEET Urban Sustainability Centre in Swakopmund over a period of 4 months from February to May and the study results were finalised in June 2018.

In this research different methods and techniques were used for data collection. This included field surveys to collect and record litter, observations of human behaviour and of the birds found, as well as careful analysis of the results and statistical testing of differences between the two sites and between two time periods, namely during the week and after weekends.

Two study sites of the same size along the beach at two urban study sites within Swakopmund were set up. See the aerial photographs in Figures 1 & 2. Site 1 was between the Jetty and the Strand Hotel and Site 2 in the area between the new shopping Mall and the south side of the Braai area.

Each site was 5m wide by 500 m long, so together covering a total survey area of 20m × 1km and followed the previous high tide mark as a centre of each transect. Four days before the study surveys started, both study sites were cleared of all litter. Thereafter, each week, for 10 consecutive weeks, from 26 February 2018 to 3 May 2018, each site was visited twice a week, once on a Monday, mostly in the morning, to record and collect all the litter that had accumulated over the preceding weekend, and once every Thursday to collect and record all the litter that had accumulated during the preceding weekdays. All the litter within each study area of 500m² was recorded and collected. To achieve the different project objectives, different approaches were applied:

3.1 Determination and assessment of the type and amount of litter found at each site, both during the week and after weekends

To determine the type and amount of litter collected at each site, separate record sheets were used. The data sheets categorised the five types of litter separately: plastic, glass, metal/tin, food and “other waste”. This was done to easily record the amount of each type of litter found at the beach.

The plastic category included; litter such as plastic bags, fishing line, food packages and other plastic. In the glass category there were mainly glass bottles like beer, soft drinks, wine and hard alcohol. The metal/tin category was soft drink cans, beer, food cans and other metals, while in the “other waste” category, all other litter was noted. Every time a survey was done all the litter found was collected and removed to avoid recording the same litter over again. Data collection was done for two different time periods, Mondays to collect the litter that accumulated over the weekend and Thursdays to collect all the weekend litter and each had its separate record sheet. The number of items of each kind of litter were then counted (tallied) to record the amount and type of litter.

3.2 Observations of the activities of people at each study site, both during the week and at weekends

Whenever possible, human activities along beaches were observed both at weekends and week-days and noted. There was no specific days set up for these observations, although this was done every week both during the week-days and weekends.

3.3 Assessment of the possible source of the different kinds of litter found at each site

Careful observations were made to try to figure out the possible source of litter found at both sites. On the record sheet two additional columns were used to record the amount of litter, one for items found on the sea-ward side of the high tide mark and another one for litter found on the land-ward side. A closer look at the litter collected and photographs of the litter were used to see if specific litter had been subjected to the sea. If no signs of sea damage nor marine colonisation were found and the litter was still in its original, undamaged form, then humans were assumed to be the source. Weather updates like wind direction and speed and tides were also checked because wind can bring in litter from inland and high tides could bring in litter from the sea.

3.4 Determination to see if there was any link between differences for litter collected during the week and after weekends and the human activity at both sites.

As mentioned in 3.1, in order to get the difference in littering between the two time periods, two separate sheets were used to separately record litter collected after weekends and during week days. As mentioned in 3.2, human activities were observed and noted whenever possible and then these two data sets were compared to look for a link between human activities at each site, during weekends and week-days and the amount and type of litter collected.

3.5 Observations of coastal birds found along the coast and seen at these sites, to determine if the litter was likely to pose any threat to them.

During data collection, careful observations of birds were done to see if there were any health hazards which items might have on the coastal birds. Any birds feeding on waste or with items around their legs were noted and dead birds were looked for.

3.6 Data analysis

Results from the litter collection and observations of human behaviour, birds and the weather were compiled in tables and presented as bar graphs.

Materials

- Camera and GPS (used a cell phone)

- Google maps app
- Recording sheets: Data collection sheets, fauna and flora recording sheets
- Waste collection Plastic bags

4. Results

4.1 A) The amount and assessment of each type of litter found at each study site both during weekends and week-days.

Figures 3 and 4 below show how much litter was found during all ten the weekday and weekend surveys at Site 1, while figures 5 and 6 show the same for Site 2.

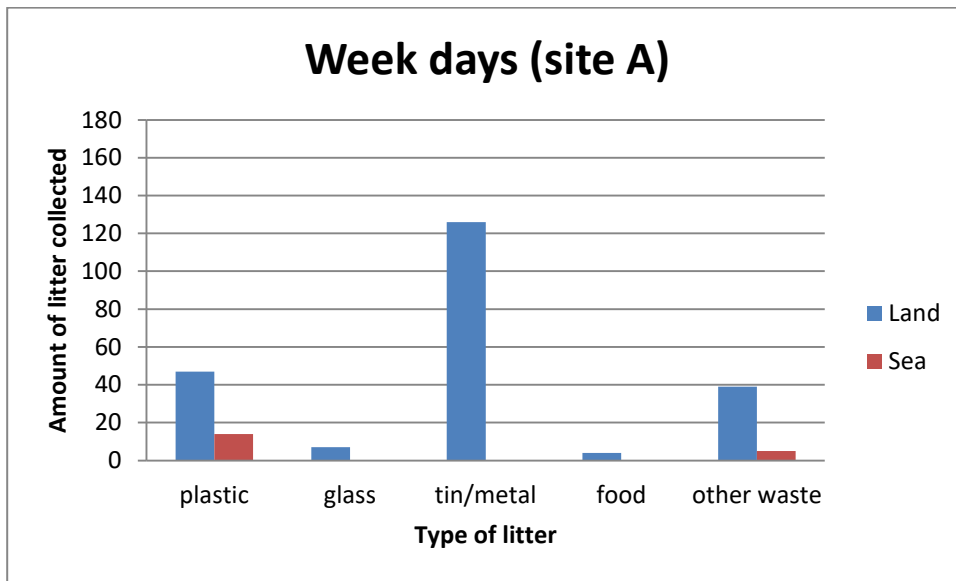


Figure 3. Amount of each type of litter collected on week-days over 10 weeks at site A

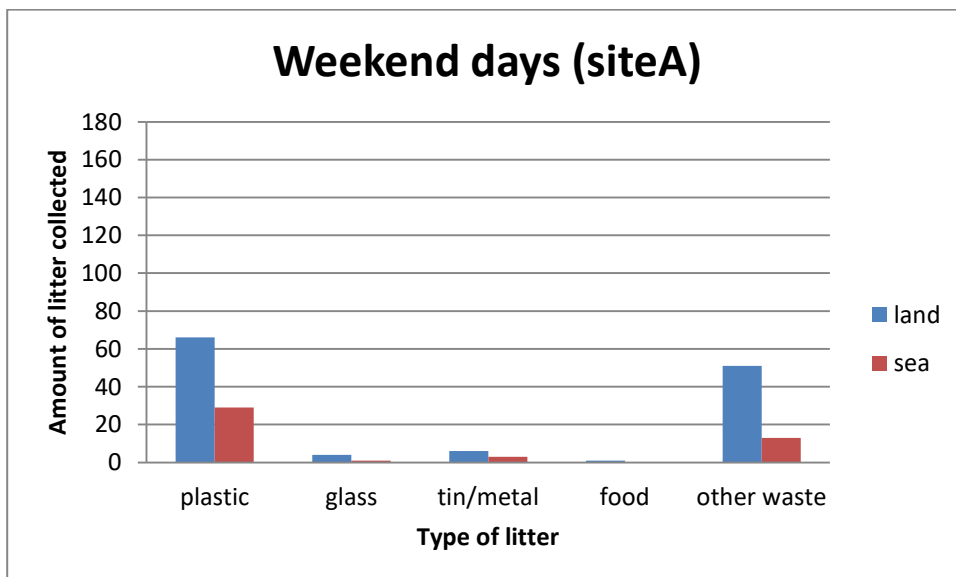


Figure 4. Amount of each type of litter collected on weekends over 10 weeks at site A

At study site A most of litter was collected during week-days as shown in figures 3 & 4. Altogether over the 10 weeks a total of 416 litter items were recorded of which 242 were collected during week-

days and fewer item 174 during weekends. The most recorded type of litter at site A was Plastic with a total count of 156 item (38%), followed by Metal/Tin with 135 (33%), 108 litter items in the Other Waste category and 12 items were recorded under the Glass category.

A paired t-Test was done to see if there was a significant difference in the amount of waste collected after the weekends and during the week at each of the two sites, this was based on the method suggested by Kaur, (2015). The test was done separately for each study site as shown in Tables 1 & 2 below.

Table 1. The t-test results for site A, to show if there was a significant difference between the litter items collected during the two time period.

t-Test: Paired Two Sample for Means		
	<i>week days</i>	<i>weekend</i>
Mean	28.6	21.9
Variance	1125.37778	393.4333
Observations	10	10
Pearson Correlation	0.23070397	
Hypothesized Mean Difference	0	
Df	9	
t Stat	0.60864116	
P(T<=t) one-tail	0.27890471	
t Critical one-tail	1.83311292	
P(T<=t) two-tail	0.55780942	
t Critical two-tail	2.26215716	

$P > 0.05$ therefore there was no significant difference between litter items collected after the weekend and during week-days.

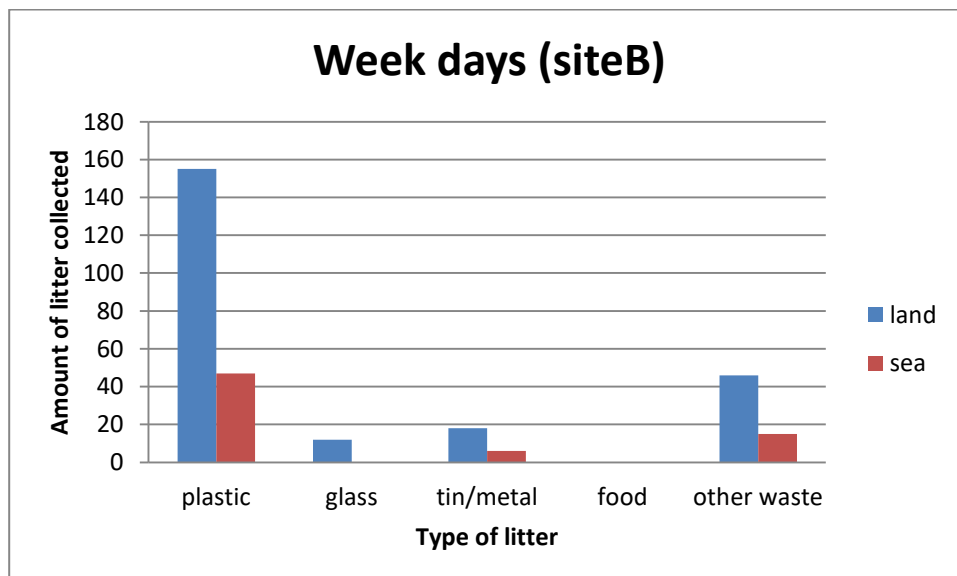


Figure 5. Amount of litter items collected at site B over 10 weeks during week-days

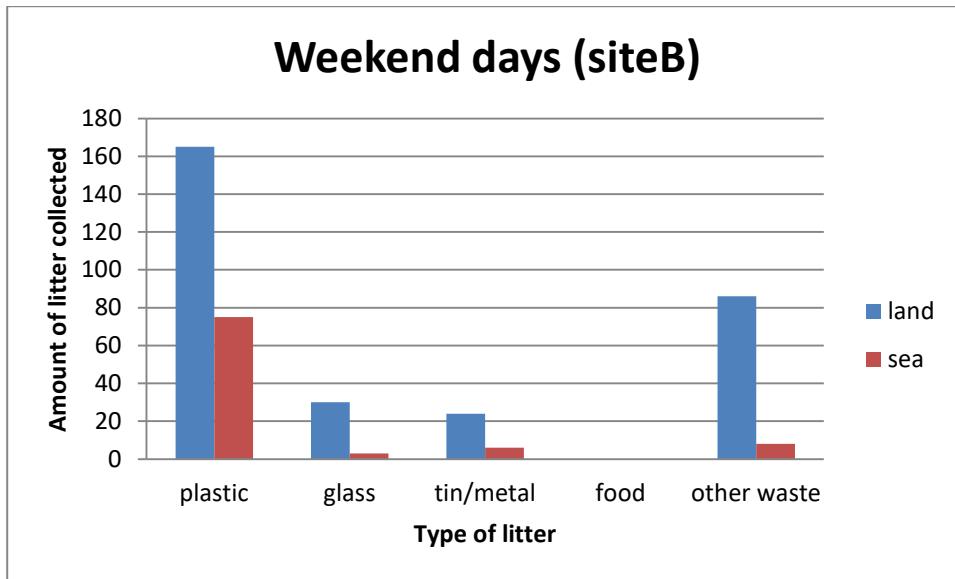


Figure 6. Amount and type of litter item collected at site B during weekends over 10 weeks

Figures 5 & 6, illustrate the end result of litter collected during week-days and weekends for site B. A total of 697 solid waste items were recorded. From site B, 301 were recorded during week days and 396 collected after the weekends. A total of 202 plastic items, 12 Glass, 18 Metal/Tin and 107 “other waste” were collected during week-days. During weekends, 240 plastic, 34 Glass materials, 30 Metal/Tin and 94 other waste accumulated, and no discarded food was found.

Table 2. The t-test results for Site B, to see if there was a significant difference in litter items collected during Weekends and Week-days.

t-Test: Paired Two Sample for Means		
	<i>week days</i>	<i>weekend</i>
Mean	32.3	43.2
Variance	552.6777778	1196.178
Observations	10	10
Pearson Correlation	0.383370258	
Hypothesized Mean Difference	0	
Df	9	
t Stat	-1.027463992	
P(T<=t) one-tail	0.165511598	
t Critical one-tail	1.833112923	
P(T<=t) two-tail	0.331023196	
t Critical two-tail	2.262157158	

As illustrated in Table 2, $P < 0.05$ meaning there was a significant difference of litter items collected between the two time periods.

4.1. B) Comparison of litter collected at sites A & B

Figure 7 below shows, how much of each type of litter was found at each site during the ten week survey period. Figure 8, A and B shows the proportion of each type of litter at each site.

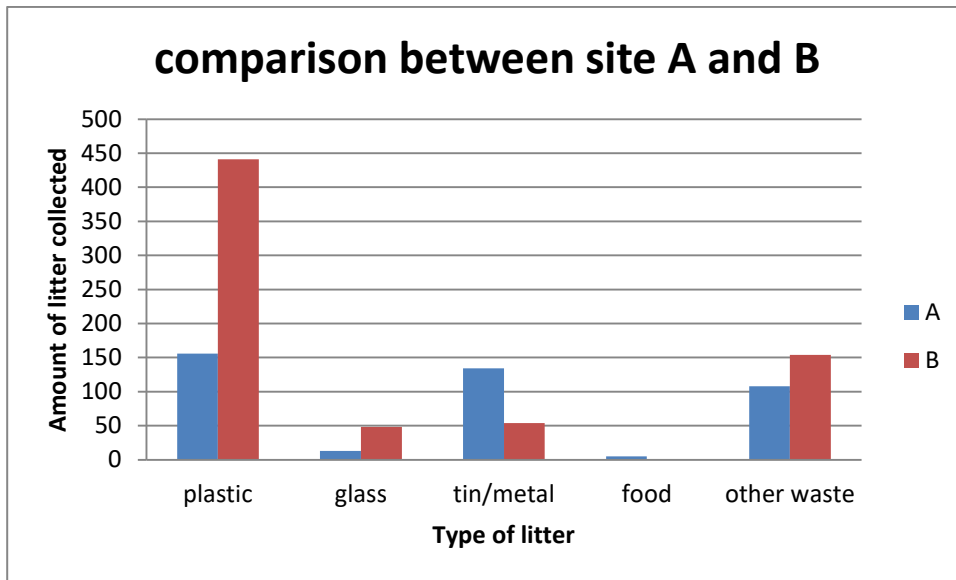


Figure 7. The comparison between the total litter collected at sites A & B

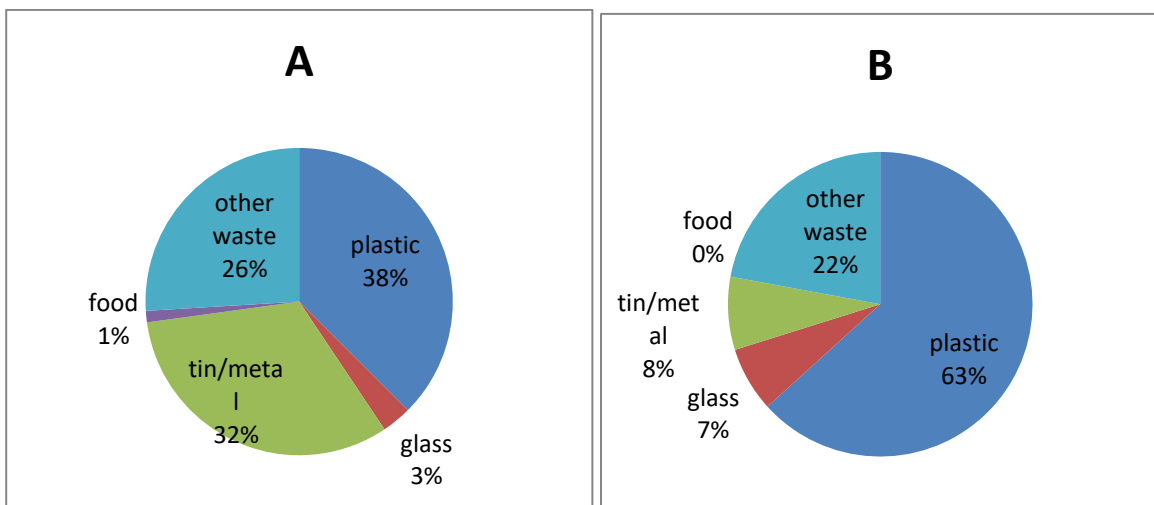


Figure 8 A and B. The proportion of different litter items collected at sites A & B

At site A, plastic and metal each made up about 1/3 of the waste items found, while a quarter was “other waste”. Very little glass or food was found. At site B, plastic made up 1/2 of the litter collected, while a quarter was from “other waste”. Few glass and metal items were found and no food.

A paired T-test was done to test the first hypothesis to see if there was a significant difference in the amount of waste collected between the two sites based on the activities of people at each site. The results of this are shown in Table 3.

Table 3. The t-Test results to see if there was a significant difference between litter items collected at Sites A & B

t-Test: Paired Two Sample for Means		
	<i>Site A</i>	<i>Site B</i>
Mean	47.8	75.5
Variance	1865.73333	2372.277778
Observations	10	10
Pearson Correlation	0.68938253	
Hypothesized Mean Difference	0	
Df	9	
t Stat	-2.3952902	
P(T<=t) one-tail	0.02010358	
t Critical one-tail	1.83311292	
P(T<=t) two-tail	0.04020717	
t Critical two-tail	2.26215716	

This hypothesis was tested using a t-test for independent values as shown in Table 3, $P < 0,05$, therefore there is a significant difference between litter collected at Sites A & B.

4.2 Human activities

As show in Table 4 below, Activities differed between the sites and more people were noticed using the beach over weekends and this was more obvious at Site B.

Table 4. Summary up all the human activities recorded at each site both for week-days and weekends during the 10 week study period.

	Week-days	Weekends
Site A	No fishing activities	Riding fat bikes along the beach
	Beach walk/ jogging with dogs	Friends/ family members having fun at beach
Site B	Buy food and eating while at the beach	Sport teams exercising on beach
	Fishing (fisherman)	Family/friends partying at the beach

		Walking on the beach
--	--	----------------------

Random observation of human activities at the two study sites showed some similar results. The beach section at site A was mostly used by tourists or visitors. The activities observed at Site A were mainly people walking, jogging or sun-bathing. Some were seen taking a drink while walking along the beach or eating while watching the sea view. Fishing activities, although not allowed, were observed only on two occasions. Most of these activities happened during weekends. Week-day activities observed included early morning bike rides, taking a walk along the beach, eating and some fun activities like playing volley ball and throwing stones into the sea.

At site B, observed activities were similar to site A, but in this case, fishing activities and walking along the beach while eating were more often observed and there were additional recreational activities, such as, sport teams exercising and families or groups of friend enjoying the beach relaxing with their drinks and food.

4.3. The possible source of litter found

Careful observation of each litter item collected showed no evidence of either sea damage or colonisation by any marine organisms. This together with the fact most of the litter were still in their original (almost new) state showed that the litter found all originated from humans and their activities.

4.4. Comparison of the two data sets collected in 4.1 and 4.2

An attempt was made to link the litter found and the activities observed at each site. Both study sites showed differences between the two time periods and human activity. Most litter was recorded during the weekend days and this can be linked to the fact that people have more time to relax during weekends than on week days. At site B, most of the human activity observed contributes to the litter. As shown in Tables 4 & 5, people were buying food and drinks at the nearby Mall, to eat and drink while at the beach, there were also more activities such as fishing and having fun especially at weekends at the beach at Site 2.

Table 5. The link between human activities and kind of litter items collected at both sites

Human Activities	Type of litter
Fishing	Fishing lines, plastic carry bag and cardboards
Family/friends partying at the beach	Glass bottles: beer, soft drink, wine and hard alcohol
Buy food and eating while at the beach	Plastic fast-food package, Styrofoam

When weather condition was also taken into account and it was clear that people avoided the beach at both sites on foggy, cold days. People also stayed away from the beach when it was covered by sea weeds, mainly brown kelp (*Laminaria pallida*) as shown in Figure 9.



Figure 9. The beach covered with sea weed mainly brown kelp, *Laminaria pallida*.

4.5. Sea bird observations

Seabirds recorded were mainly gulls, Kelp gulls (*Larus dominicanus*) and Hartlaub's gulls (*Chroicocephalus hartlaubii*) that are both scavengers. Also seen were Cape cormorants (*Phalacrocorax capensis*) near the shore, but they are known to feed on fish in the sea. Both gulls tended to stay around the fishermen at site B. Neither injured nor dead birds were recorded. However it is known that they can ingest waste items such as fish hooks attached to bait and get their legs wrapped in fishing line (Bergmann, Gutow and Klages, 2015).

At the moment, littering does not pose any danger to the coastal birds. The most likely threat littering may have is on the Hartlaub's gulls that like scavenging food around the fisherman, it might be possible for these birds to accidentally ingest fish lines and hooks. Other littering such as plastic might also pose danger but this will be hard to tell because one has to open up the birds stomachs or gizzards to have a clue about what they feed on.

5. Discussion

5.1 Assessment of amounts and types of litter found during the survey and comparison between sites

The total number of litter items collected from a total survey area of 5000m² over ten weeks amounted to 1113 items of solid waste at both sites. The proportions of each type are shown in Figure 11.

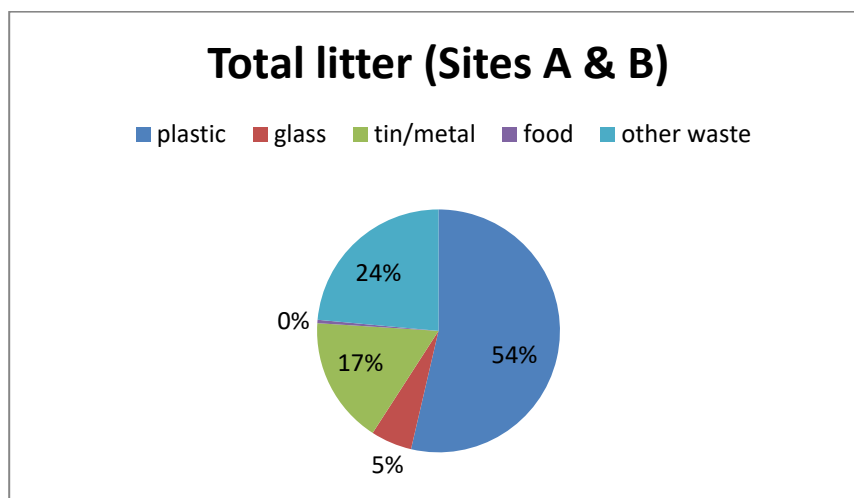


Figure 11. The total proportion of litter items collected at both sites over a ten week survey period.

World-wide there is growing concern about ocean pollution especially from plastic and this was highlighted this year as the theme of World Ocean Day on 8 June. This study has shown that Namibia also contributes to this problem. Most of the solid waste found on the beach in Swakopmund during this study was plastic. As shown in the pie graph in Figure 11, plastic made up 54% of the items found.

5.2 Human activities at both sites and how they relate to litter

It was clear from the results that litter can be directly related to human activities. A significant difference was found between litter found at Site A and Site B which can be explained by the different activities and people's attitudes towards litter at each site. At site A near the main beach, the people were mainly tourists who are more concerned about the environment and most likely more aware of global pollution concerns. While at site B local fishermen and people going there to relax seemed not to care. They simply dumped the bait boxes, fishing line, food packaging, plastic and glass bottles even though there were 15 rubbish bins at the site.

This was confirmed by the fact that less litter was found on the beach when fewer people went there, for example after weekends compared to before and also following cold, foggy days as well as after kelp covered the beach. At site A there was no significant difference between litter found after week-

ends and after week-days, while at site B there was a significant difference. This is probably because, there is less difference between the numbers of tourists and how they used site A at the weekends and in the week, while the local people at site B were much more likely to go there to relax during the weekends and dump their rubbish, than during week-days.

Other studies on human behaviour and littering concluded that people litter more if their surrounding is already dirty than when the area is clean (Nyawira and Nairobi, 2016). This is also likely to be true on the beaches in Swakopmund and may be why more litter was found overall at Site B, (see figure 7). Currently the Municipality cleans up on Thursday mornings and on Mondays, possibly by shifting the Thursday clean up to Friday afternoons, people coming over the weekend would find a clean beach and might be less likely to simply dump their waste.

People avoided going to the beach when the beach conditions were not favourable for people to enjoy the beach in comfort. When the beach were covered with kelp fewer people went there and so there was less littering. This was because kelp made the beach smelly and covered the sandy beach that most children like playing on. In addition, fisherman also avoided going fishing when the shore was covered by floating kelp because their fishing lines and hooks got tangled up in this kelp and this reduced the number of fish caught. Most of the time fishing activity had a direct impact on the litter found as shown by the results of this study. More plastic fishing line and cardboard bait boxes were recorded at Site B than at Site A and more fishermen used Site B as fishing was not allowed at Site A.

This type of information is important for the Municipality of Swakopmund to know the best time to collect rubbish and clean up at the beach and that this can be different at different beaches depending on who uses them and for what. It is also useful to NaDeet who should consider targeting fishermen.

5.3 The source of the litter found

Careful study of each litter item showed neither sea damage nor colonisation therefore it can be concluded that very little of the litter found on this Namibian beach had washed in from the sea. This could be due to the strong Benguela current, rough seas, and the regular coastline with few calm inlets where things floating in from the sea can collect. Further it is possible that litter which could have been washed onto the land during one high tide was again pushed back into the sea at the next high tide. It is certainly possible that litter that is dumped by people on the beach between high tides can was out into the sea. High seas were able to clear the kelp from the beach overnight sometimes (personal observation) and therefore it is likely that any waste tangled up in the kelp or hidden there would also wash out to sea, contributing to the global problem of ocean pollution. Thus it is likely that there is a net input of waste to the ocean and that not much waste from the sea collects on this beach.

5.4 Sea bird observations

Over the ten week survey period, no bird injuries were recorded, nor were any litter items found tangled around bird's legs. Possible threats were observed to gulls that sometimes scavenge around fish-

ermen. The possibility that these gulls could feed on fish bait on a hook or tangle themselves up in fish line while walking on kelp was very high. It is known and proved in other studies that gulls mistakenly feed on litter items such as lighters and fishing hooks or get tangled up in fishing line while walking or scavenging along the beach , as shown in figures 10 & 11 below.



Figure 10. Kelp gull with a fishing and hook
Source: S Roux



Figure 11. A gull with litter items inside its stomach
Source: S Roux

5. 5 Usefulness of the information gained to the Municipality of Swakopmund and NaDEET

The results have shown that the most recorded litter items were plastic items. From this study, NaDEET should can then come up with a practical solution like regular beach clean-ups and provide information through a targeted awareness programme to learners and adults, particularly fishermen about the possible environmental problems caused by different types of litter especially plastics. NaDEET should also use their sustainable house display to promote the usefulness of using clothing or canvas shopping bags. These can used for a long time and will then reduce the number of single-use plastic bags. In the long run this will not only reduce plastic and ocean pollution, but also save natural resources used for making plastic.

The present cleaning schedule of the municipality of cleaning the beaches on Mondays and Thursdays is good for site A, but for site B another day, possibly Wednesdays should be added because this beach area is used daily by the people and the Thursday clean up moved to Friday afternoons to provide a clean beach to people going over the weekends. Perhaps they could also consider putting up a recycling bin at the parking area at site B. This will help save Rent-a-Drum time in sorting out the different types of litter items for recycling. The municipality should make sure that they provide enough information about the recycling bins to the residents. It is a fact that people are less likely to litter in a clean area than unclean area, (Nyawira & Nairobi, 2016), so if the Municipality cleans up more often and also does so on a Friday, people visiting at weekends might litter less.

6. Conclusion and Recommendations

The study has shown that more litter was collected at Site B, 697 solid waste items, than at Site A where 416 solid waste items were recorded. This difference between the litter collected at site A and B was affected by the different ways that people used these two beach sections. At site A no fishing activities were allowed, this then reduced the amount of plastic and cardboard compared to site B

where fishing was allowed and much more fishing line and bait boxes were recorded. Another factor that caused this difference between the two sites was that site B was mostly used by local people compared to site A which is more of a tourist area, it was obvious that tourists were more concerned to not litter. This difference between the two sites was confirmed by the statistical test; the null hypothesis was rejected proving that there was a significant difference between the litter items collected at the sites.

The study has shown that changes in weather conditions, especially fog and tides also had an effect on litter accumulation. During foggy and cold days, less people were observed on the beach and less litter was recorded compared to when the weather conditions were moderate to good, then litter increased. Another aspect that also reduced the accumulation of litter was when the beach was covered with kelp. This kelp made the beach unpleasant for people to spend time there and less litter was recorded. No litter had obviously come onto the beach from the sea and gulls were noted scavenging near fishermen.

In conclusion, people were the main culprits of beach litter. Plastic is really becoming an environmental issue that needs to be addressed. Even though there were rubbish bins at both sites people still did not use them. This might be the lack of awareness and ignorant behaviour in people or more likely that they simply do not care. Therefore there is a need for NaDEET to focus on an improving awareness about beach litter particularly plastic in Swakopmund. NaDEET should use the Urban Sustainable Living display to also address the environmental problems caused by plastic pollution and other solid waste, as well as help organise practical awareness activities like beach clean ups. Using such opportunities to talk to people and the media to provide clear information about littering. Through this even less concern citizens will become aware of their environment and that they can do something to help.

During the whole project some limitations were experienced. There is a need to do this study over a wider area to get more information. It would also be useful to include interviews as part of the survey to get people's views on littering. Working alone was not easy and it is recommend that future studies should be done by at least two people so that more accurate information can be obtained, so that one person can record what is find while the other collects and sorts the litter items

The Swakopmund municipality should work towards implementing restrictions on the usage of single-use plastic items like plastic bags and plastic straws and promote people to use re-usable shopping bags made of cloth or canvas. Some shops in Swakopmund are already aware of this.

7. Acknowledgements

Thank-you to all the people that helped with this project. Thanks to Viktoria Keding , Director of NaDEET and my supervisor, for offering me an opportunity to do my Work Integrated Learning at NaDEET, and for the opportunity she gave me to attend the NEEN conference and NamibRand game count. These opportunities have increased my knowledge in Environmental Education programmes, again thanks to her for always directing me to where I could get the information that I needed for my

project. Thanks to Andreas Keding and Kevin Roberts, my moderator, for helping me set up the study sites and information on the different methods to use. Thanks to Shirley Bethune, my Tutor, for editing and providing all the relevant information for my report writing. Thanks to Pandu Haidongo for helping in editing my reports. Thanks to Laurin for helping during data collection and my appreciation to the late Sue Roux for the coastal bird images.

8. References

- Bergmann, M., Gutow, L. and Klages, M. (2015) *Marine anthropogenic litter, Marine Anthropogenic Litter*. doi: 10.1007/978-3-319-16510-3.
- Branch, G.M, Griffiths, C.L, Branch, M.L, Beckley LE. (2007). *Two Oceans: A guide to the marine life of southern Africa*. Cape Town, South Africa: Struik Publishers
- Mannheimer, C.A. & Curtis, B.a (eds) 2009. *Le Roux and Muller's Field Guide to the Trees and Shrubs of Namibia*. Windhoek, Namibia : Macmillan Education Namibia
- Nyawira, P. and Nairobi, O. (2016) 'An Assessment Of Attitude And Behaviour Towards Littering'.
- Kaur, J. (2015) 'Techniques Used in Hypothesis Testing in Research Methodology – A Review', *International Journal of Science and Research (IJSR)*, 4(5), pp. 362–365.
- Sinclair, I., & Hockey, P. (2005). *Birds of Southern Africa* (P. Abbott). Cape Town, SouthAfrica: Struik publishers.