IBDP Geography Internal Assessment

Investigation on the impact of tourism on coral reefs and beaches in Tioman Island.

Fieldwork Question:

How does tourism affect the coral reefs and beaches in Tioman Island?

Word Count: 2500

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Introduction

Aim:

To investigate the impact of tourism on the coastal environment of Tioman Island.

Fieldwork question:

How does tourism affect the coral reefs and beaches in Tioman Island?

Hypothesis:

1. There is a positive correlation between the amount of tourists' land use and the amount of beach litter.
2. There is a negative correlation between the number of people in hotels and the coral diversity.

Geographical Context:

This investigation is related to Option E: Leisure, Tourism & Sport. It relates specifically to strand 4 discussing the consequences of unsustainable touristic growth on rural tourism spots, with connection to human factors explaining the growth of tourism in strand 2.

Unsustainable tourism is tourism activity that does not take consider fully its current and future economic, social and environmental impacts while addressing the needs of visitors, locals, the industry, the environment ("Sustainable Development of Tourism"). It includes the impact of human factors, such as building secondary tourist resources like hotels without considering the environmental carrying capacity - "the maximum number before the environment becomes damaged" (Delaitre). It often has negative impacts on the environment, which stunts the growth of tourism in a niche rural tourism spot that relies on its primary tourism resources.

Locational Context:

Figure 1 Locational Context of Malaysia (Image from [Google Map] modified by author)

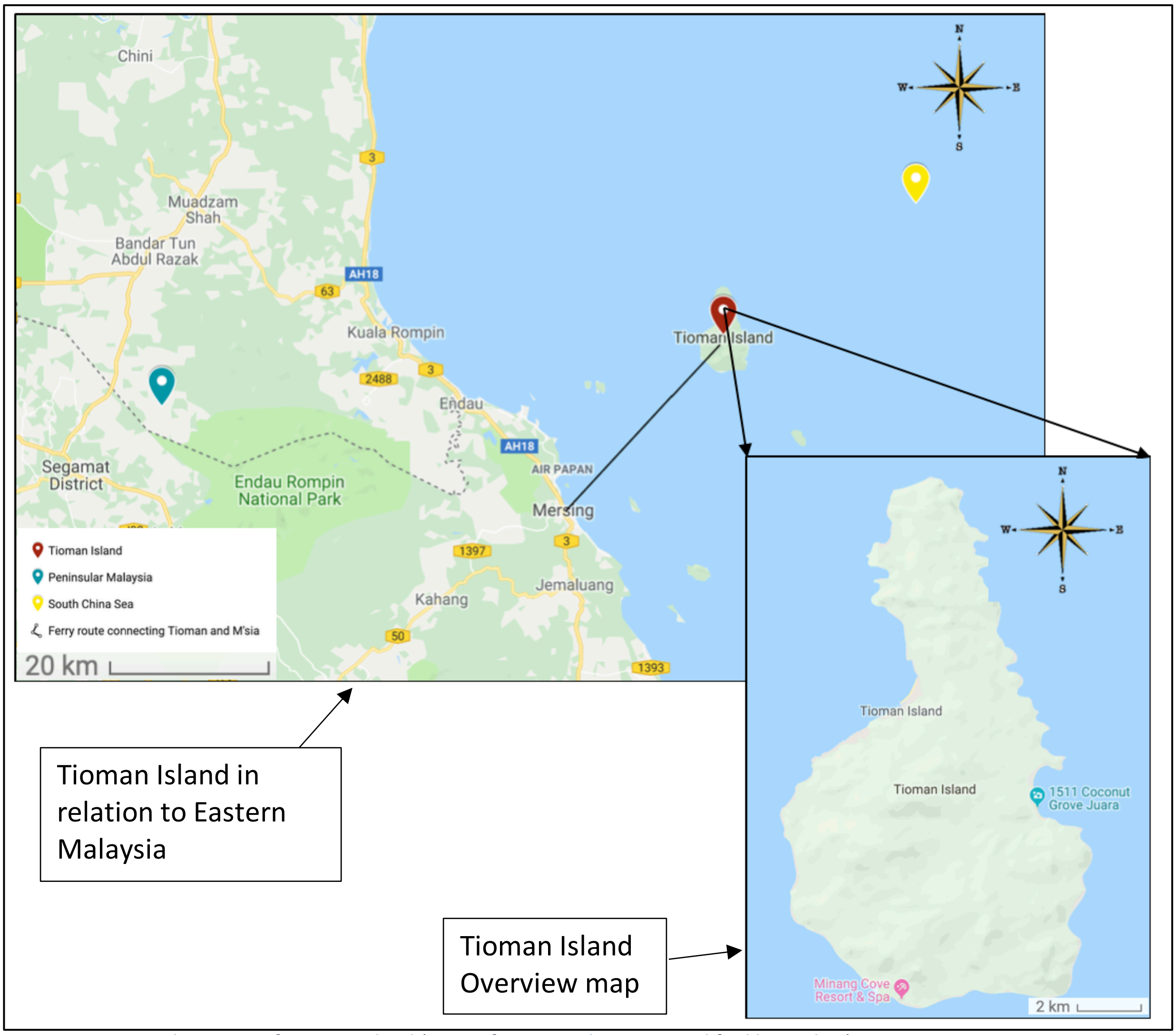

Figure 2 Locational Context of Tioman Island (Image from [Google Maps] modified by author)

Tioman Island lies on the South China Sea on the east coast of southern Malaysia. It is a popular niche tourist destination, which offers primary tourist sites such as diving spots, tropical rainforests, and coral reefs. So, it is famous for its diving tourism and ecotourism.

Tioman Island allows for an investigation into how tourism activity and the secondary tourist resources, such as hotels, have affected the coastal environment, which in turns lead the island into the stagnation stage of Butler's Model (figure 4), as demonstrated by the statistics in figure 3 showing a slow decline in number of visitors since 2016, suggesting that the tourism spot has reached its peak of carrying capacity in 2016 at 276,878 visitors.

NO	DESTINASI	2010	2011	2012	2013	2014	2015	2016	2017	2018
7	PULAU TIOMAN	233,923	236,811	216,509	232,102	268,784	270,164	276,878	263,261	256,065

Figure 3 Data showing tourists arrival in Tioman Island. (Image from: "Statistics of Tourist Arrival." 22 Feb. 2019, https://www.pahangtourism.org.my/index.php/about-us/downloads/file/96-tourist-arrival-2018. Accessed 22 May 2019.)

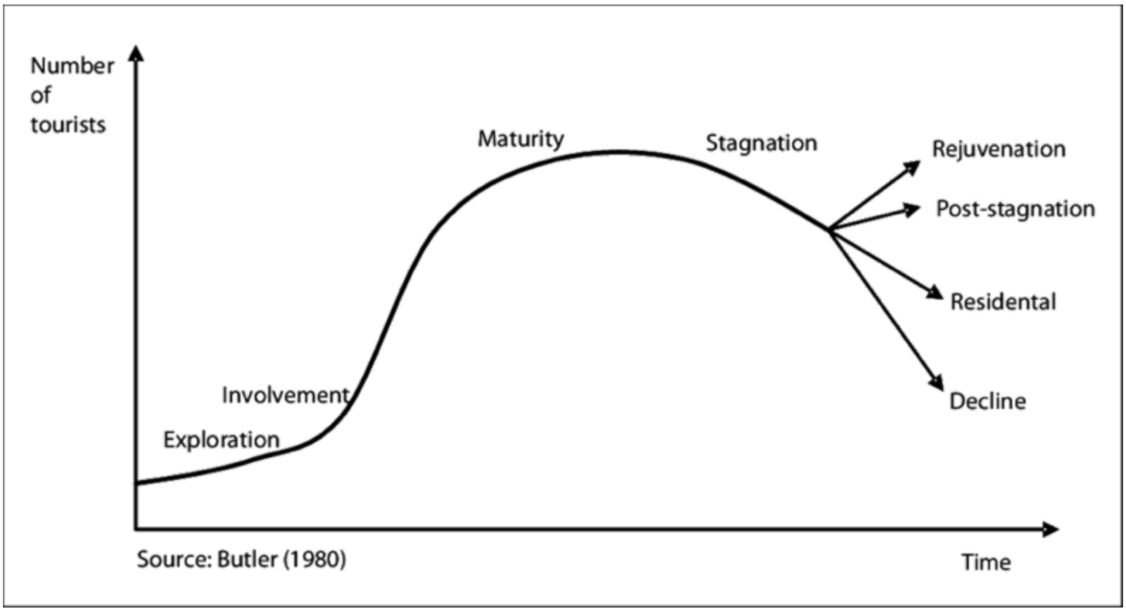

Figure 4 Butler's Model (Image from: Nordin, Sara, and Hans Westlund. "ResearchGate." ResearchGate, Jan. 2009, https://www.researchgate.net/figure/BUTLERS-LIFE-CYCLE-MODEL_fig1_265456483. Accessed 22 May 2019.)

Methodology

3 sites were chosen for data collection, as illustrated in figure 5 through stratified sampling, because those are the three most accessible places with the most tourists, where the impact of tourism can be easily observed.

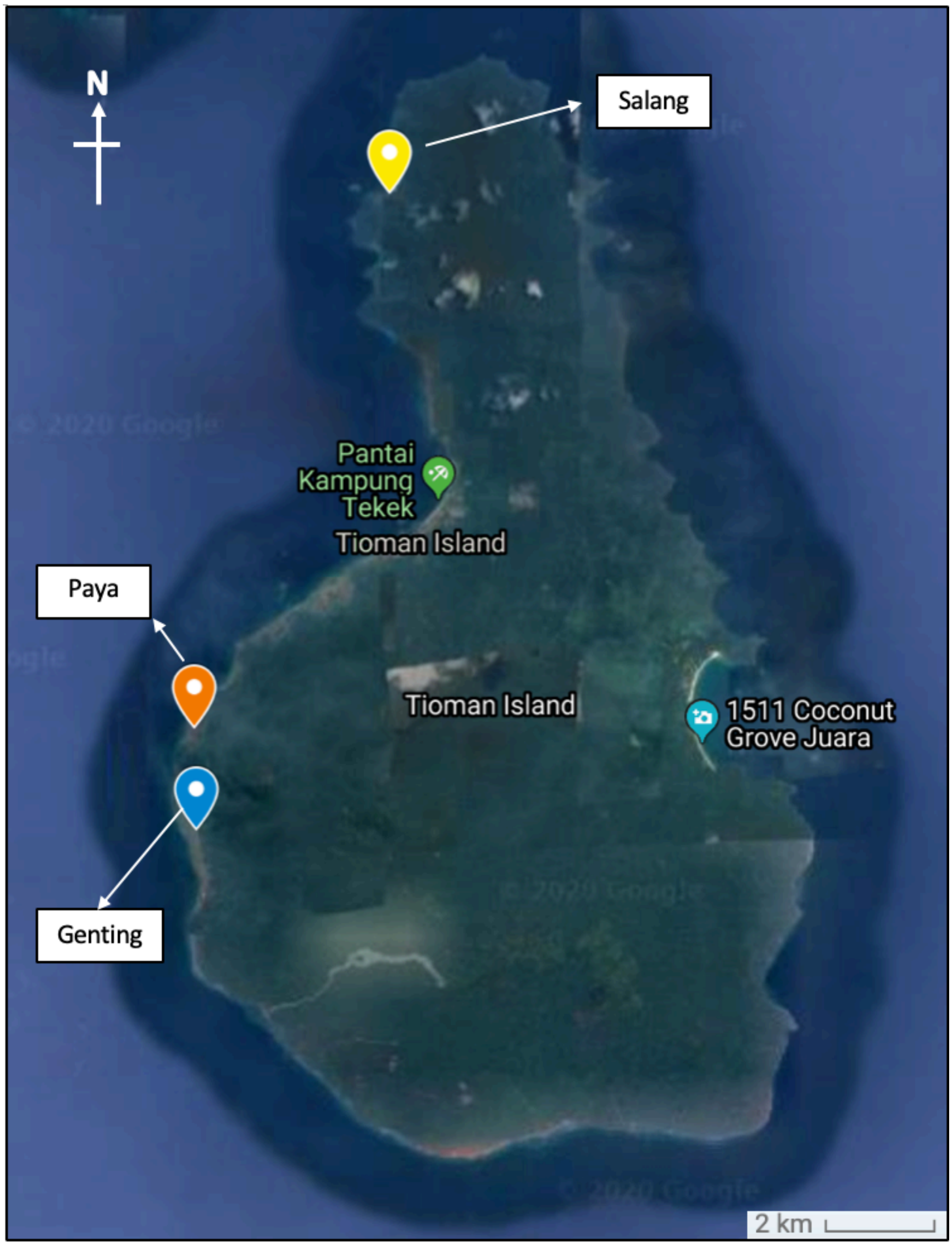

Figure 5 Sites of data collection (Image from Google Map modified by author)

Transects were used for collecting coral data, as illustrated in figure 6. In pairs in a straight line, six data (substrate, coral diversity, fish diversity, damage, coral health and indicators species) are collected collectively. Each pair, through stratified sampling, collected one specific data to reduce time. The sites of transects were selected through random sampling, where any spot over coral reef close to the jetty could be selected to make sure that the impact of tourism is accounted for.

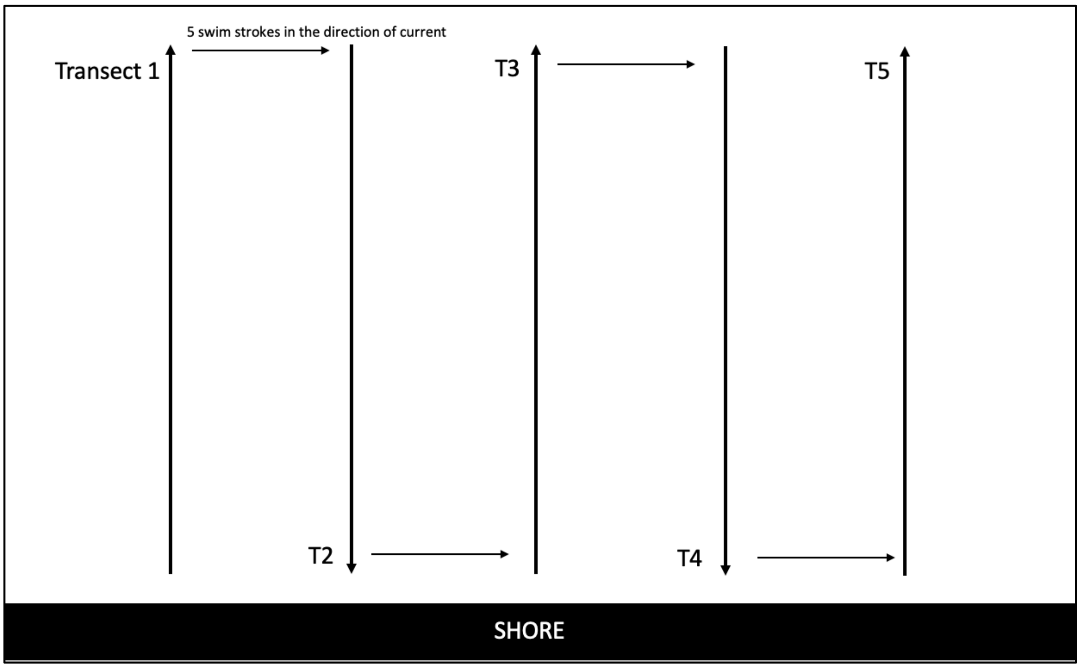

Figure 6 Diagram showing Transect Formation (Image from author)

In each transect, data was recorded in a dive slate every 10 seconds for 2 minutes; this is a systematic sampling to make sure that the data are controlled. A total of five transects were done to make sure that the data averages can be obtained.

For hotel data, such as prices and number of rooms, students interviewed 5 randomly selected resorts to provide an unbiased data. Systematic sampling was used in collecting land use data, as illustrated in figure 7, to avoid an under-representation of specific data. The total distance of 400m was measured using a trundle wheel, and the land use was recorded every 40m.

Number of tourists were collected through counting the number of locals and tourists for 30 minutes. Systematic sampling is used as tourists counts were always carried out right next to jetty, as specified in figure 7, as it is the central location to the town where people pass by the most often.

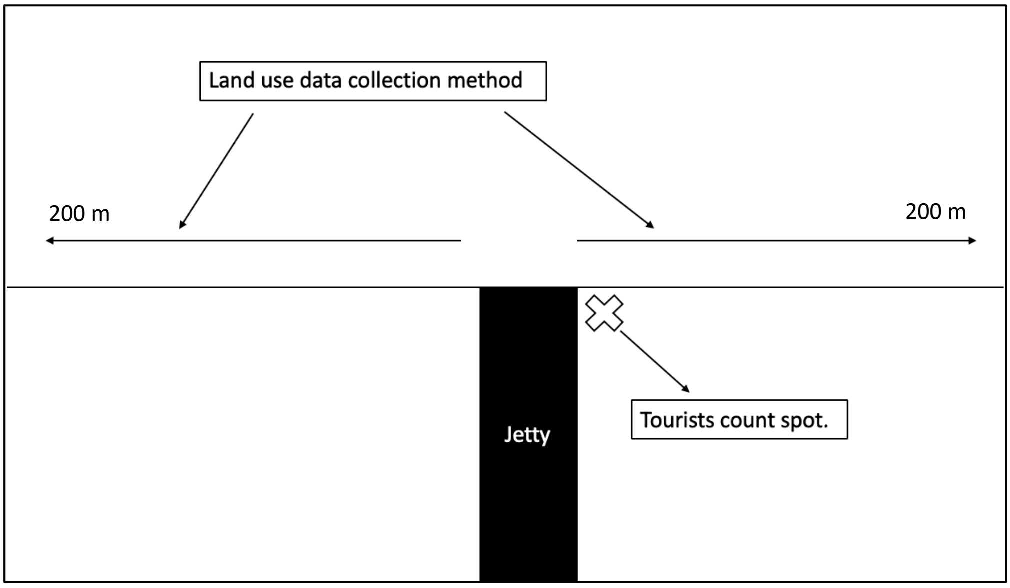

Figure 7 Diagram for land use data collection and tourists count (Image from author)

Figure 8 shows how beach litter data is collected. The site was selected through random sampling close to the jetty since it is difficult to standardize the high tide and low tide point.

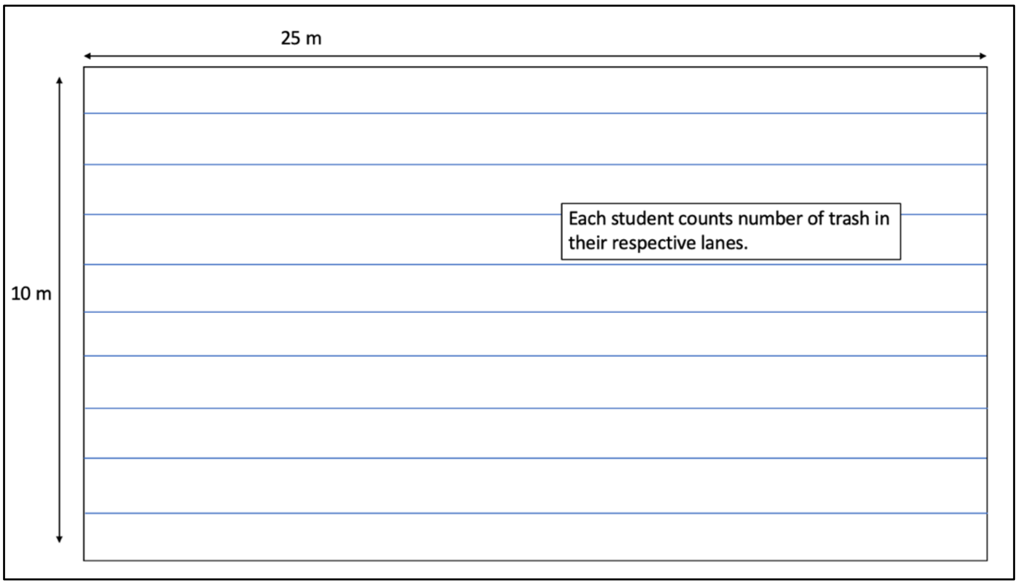

Figure 8 Diagram showing Beach litter data collection (Image from author)

All data collection processes above are repeated in all three sites. Chi-squared test, to compare two groups of categorical data, and Mann-Whitney U test, for continuous data, are used to test the significance of the statistics and findings (du Prel).

Data Presentation & Written Analysis

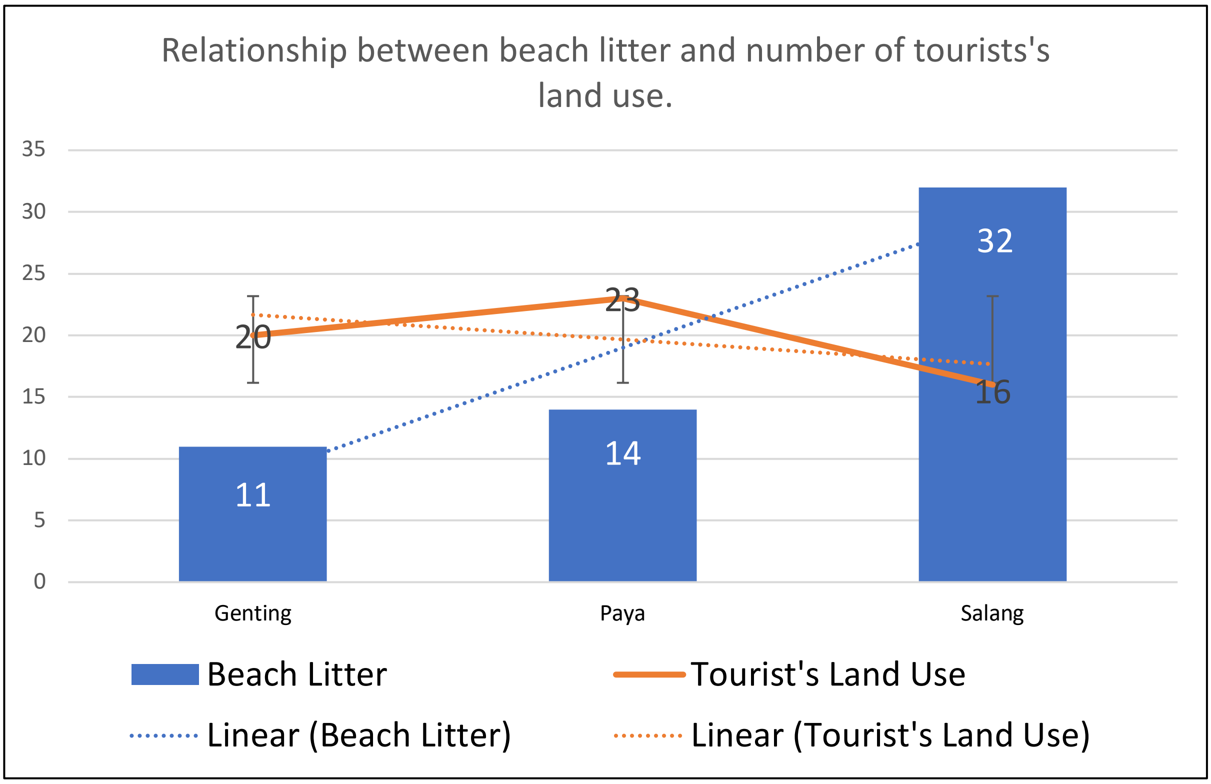

Figure 9 Combo graph. (Graph from author)

There is a negative correlation between the amount of beach litter and the amount of tourist's land use according to figure 9 as the trendlines shows that as tourist's land use decreases, the amount of beach litter increases. This proves my hypothesis incorrect.

However, comparing just Genting and Paya, it can be seen that there is a positive correlation between tourist's land use and beach litter. Paya has 3 more tourist's land use than Genting, and it also has 3 more beach litter than Genting. This is because one of the negative impacts of tourism is land pollution. More tourist's land use means more tourists, which in turn means more waste problems due to unfamiliarity of the wastage systems, the lack of proper wastage system to cope with the sheer number of tourists, or just the irresponsibility of the tourists. This part of the result is supported by the Chi-squared statistical test result between Genting and Paya with only 3% insignificance.[1]

[1] Refer to appendix 1

Salang provides an anomaly to the graph as the tourist's land use is actually lower in relative to the amount of beach litter. Salang has 32 litters, the highest among all sites, but only has 16 tourist's land use, the lowest among. This anomaly is also supported with the statistical test, which suggests that the relationships of Salang with Paya and Genting are 43% and 11% insignificant respectively.[2] This could be due to most of the beach litter from Salang may not necessarily be from tourists, as samples that were collected there contained glass, rubber, and cigarette buds, which are daily objects that could point to the locals more. Figure 10 shows that there are actually more of those common household objects in Salang than other two areas. This skewed the data collected as the impact of tourism may be minor compared to that of locals.

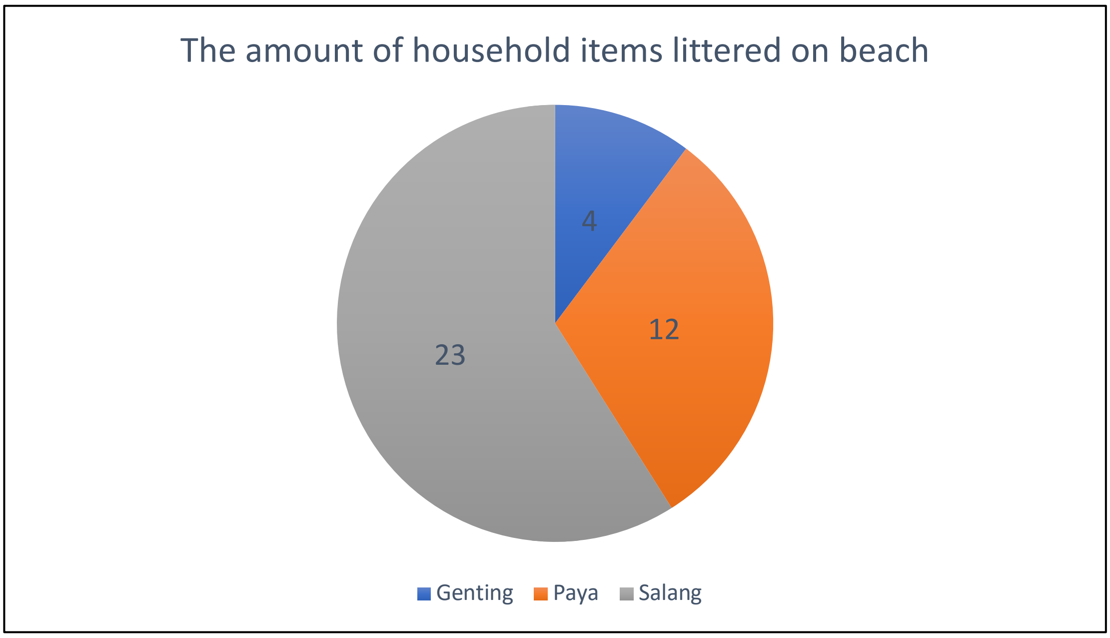

Figure 10 Pie chart. (Graph from author)

It could also be that Salang does not have the same level of sustainability practice as other sites, which use the practice as tourism strategy to attract tourists through making the site cleaner and longer-lasting. In fact, organization like Rumah Hijau has been promoting recycling discarded items on the island (Latif 2018). So, sites like Genting and Paya may

[2] Refer to appendix 1

have been more successful in doing that than Salang, thus also skewing the data on Salang. Also, the fact that Paya has 23 tourist's facilities and land uses, the highest among all three sites further suggests that the site is a popular tourism spot, which refers to that Paya will definitely receive the most attention in terms of sustainability practices since the government and NGOs would want the site to be cleaner and longer-lasting for economic benefits in the tourism sector. This will also make the data on Salang to be skewed, as Salang is not the most famous tourism spot on the island since it has the lowest amount of land use.

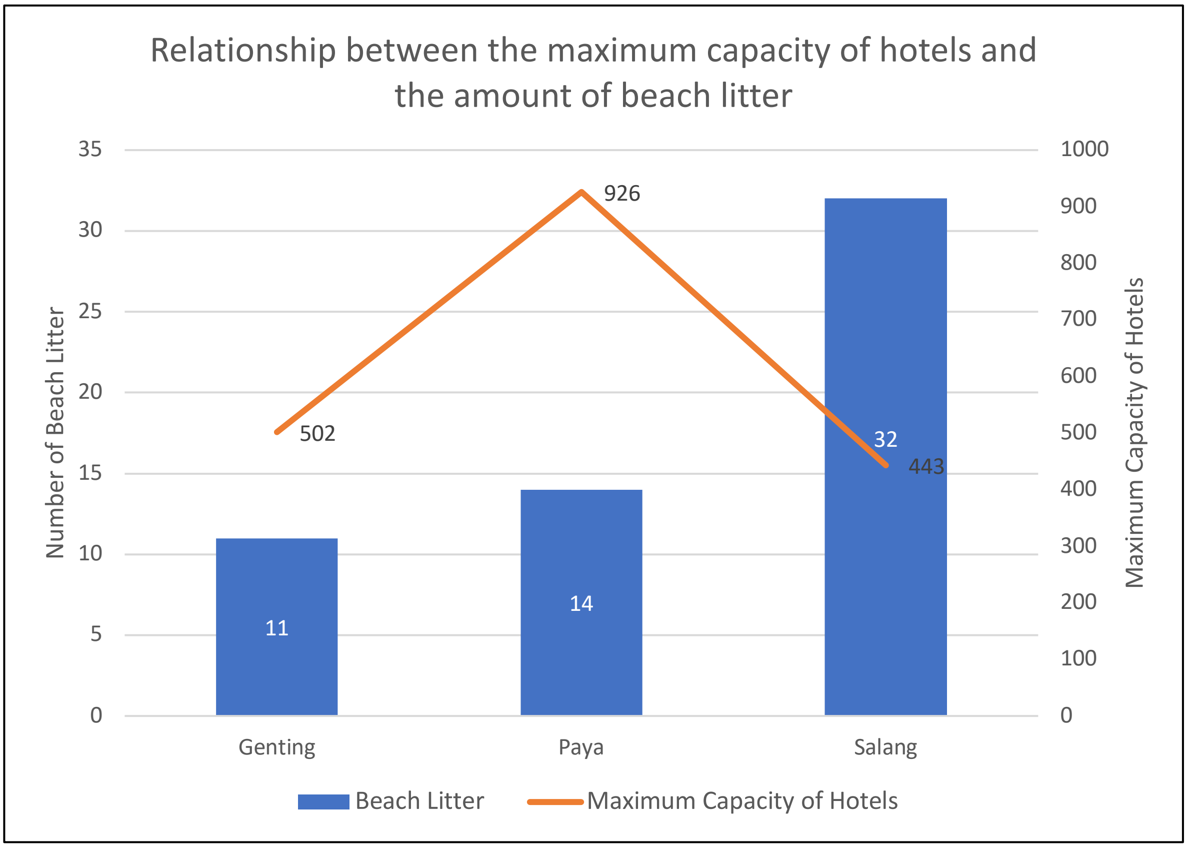

Figure 11 Combo graph. (Graph from author)

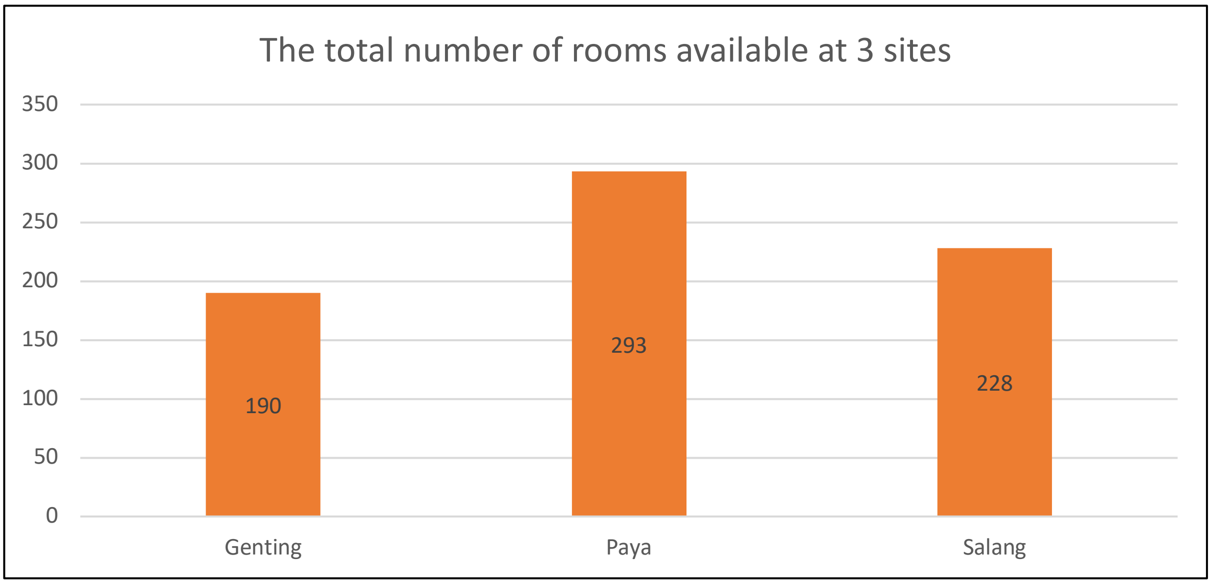

Figure 12 Bar graph. (Graph from author)

Figure 11 shows that Paya has the highest maximum capacity of hotels, with 926, followed by Genting then Salang, with only 443 capacity. Looking at Genting and Paya only, it can be deduced that the maximum capacity of hotels increases as beach litter increases. The maximum capacity of hotels often correlate positively with the number of hotel rooms, which is supported in figure 12 with Paya also having the most number of rooms – 293 in total. Having more rooms means a higher amount of land dedicated for tourists. Therefore, this data supports the hypothesis that as the number of tourist's land use increases, the amount of beach litter increases.

Similarly, Salang is an anomaly since it is not expected that Salang will have the highest amount of beach litter since it does not have the highest maximum capacity of hotels nor the highest number of rooms. However, the reason of this anomaly is the same as earlier regarding sustainability practices. In addition to that, it may have something to do with the cost of the rooms in Salang. According to figure 13, Salang has the lowest average prices of resorts, with only RM138. This mean that the standard of the resorts in Salang is the lowest, thus it can be inferred that there would be a lower income. This means a possibly lower investment put into cleaning up in Salang than the resorts in other sites, thus explaining such a high amount of beach litter.

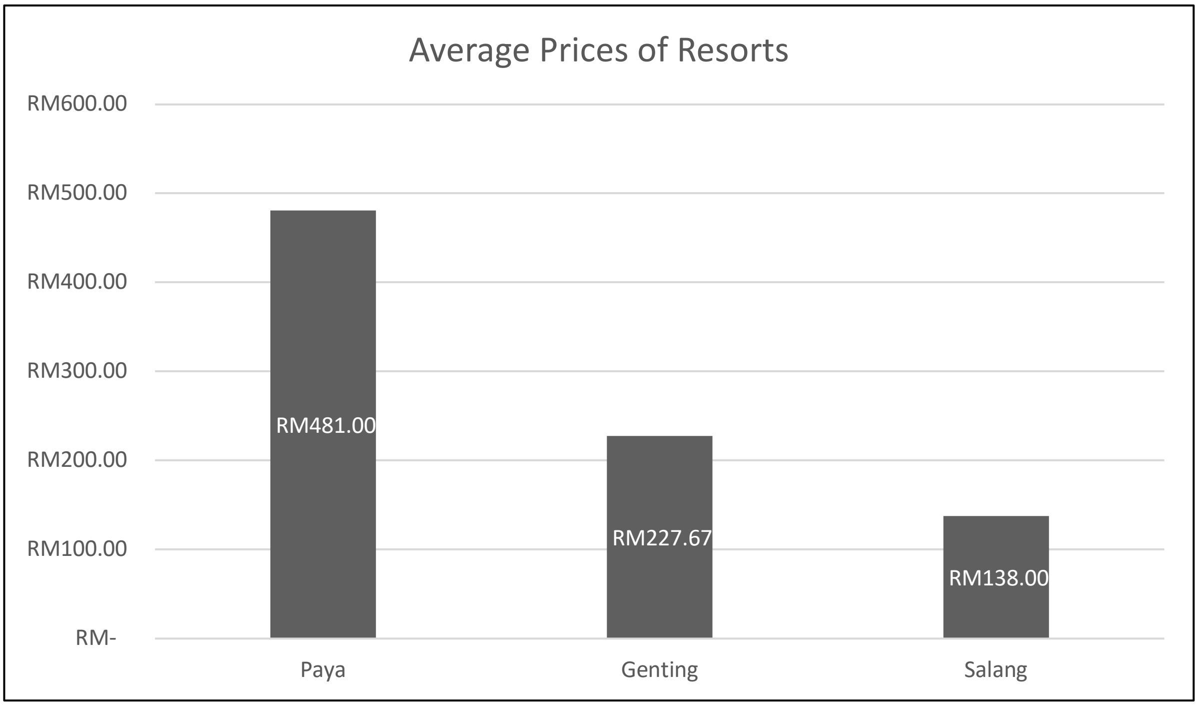

Figure 13 Bar graph. (Graph from author)

So far, it is discovered that from looking at the overall data, the hypothesis is incorrect since the overall trends suggest negative relationship. However, the statistical tests have shown that Salang's data are insignificant, thus supporting the claim that its data are anomalies, which may be caused by the various reasons discussed. Thus, disregarding the insignificant data, our hypothesis about land use and beach litter can be considered correct to some limited extent.

Unsustainable tourism can also negatively impact the coral reef, which leads on to the next hypothesis.

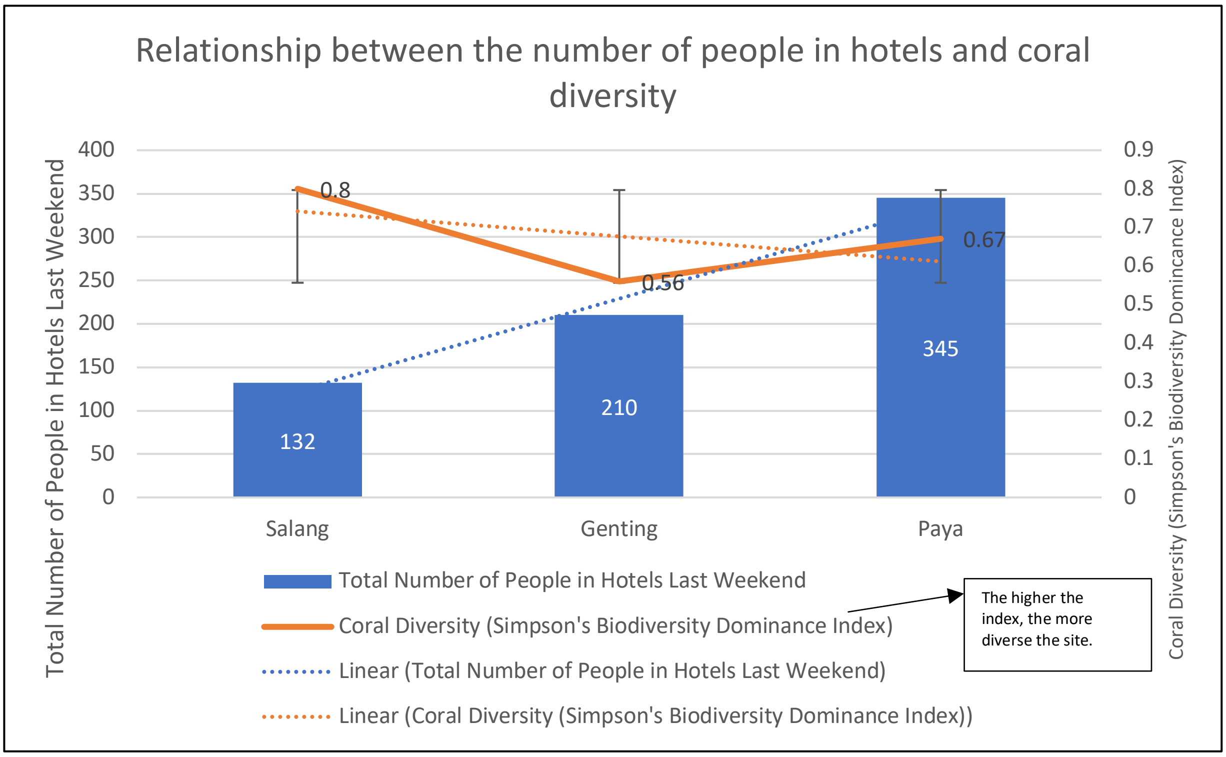

Figure 14 Combo graph showing relationship between number of people in hotels and coral diversity. (Graph from author)

In figure 14, there is a negative correlation showing the coral diversity decreases as the number of people in hotels last weekend increases. This proves my hypothesis correct. This occurs because if there are more people in hotels, which suggests more tourists, there is a higher chance that there will be more damage done to the coral, thus reducing the coral diversity. More tourists often mean that the tourism is unsustainable since it will be harder to control the crowd, and it may also exceed the environmental carrying capacity, thus negatively impacts the health of corals.

There is, however, an anomaly in Genting as the index is 0.56, which is the lowest, even though Genting only has the second highest number of people in hotel last weekend, with 210 people. This could happen due to factors like monsoon that may kill off many corals, thus skewing the data.

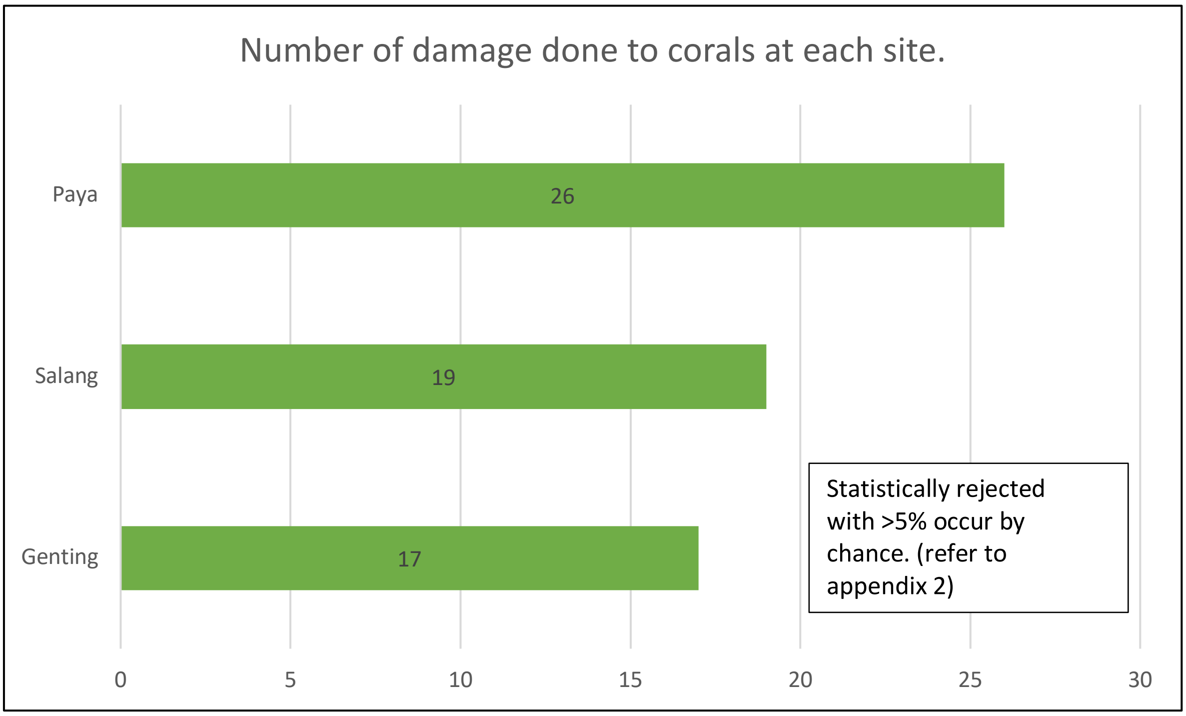

Figure 15 Horizontal Bar graph. (Graph from author)

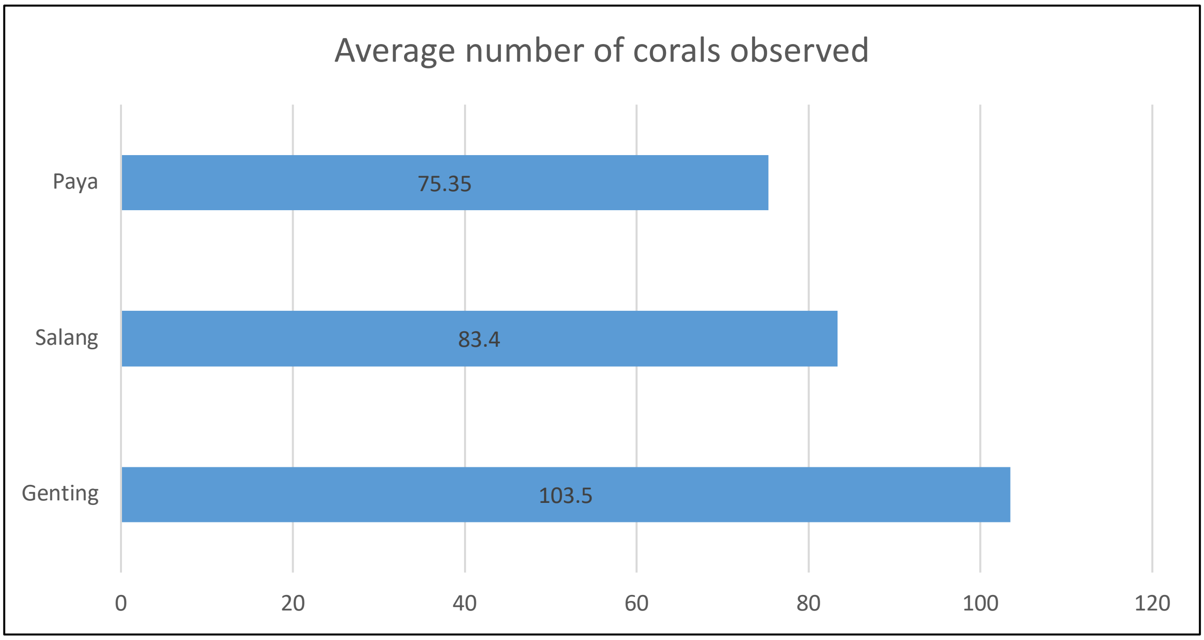

Figure 16 Horizontal Bar Graph. (Graph from author)

Figure 15 & 16 support the result of hypothesis, because the greater the damage, the less the coral diversity as number of corals reduces. The pattern shown in this graph fits perfectly as Paya , which has the lowest number of corals – only 73.35 - has 26 damages, the highest among the 3 sites. Similarly, Genting with only 17 damages, the lowest among all three, has the highest number of corals – 103.5.

A better way to look at it is through the severity of bleaching. Coral bleaching is caused by water pollution due to coastal development from unsustainable tourism. Even though coral bleaching can also happen due to climate change, hence an increase in sea temperature, the effect of human activities is more prominent as it takes place at a faster rate. Figure 17 further strengthens the hypothesis as it can be seen that as the bleaching becomes greater, the number of tourists in hotels also increases. Paya has a bleaching level of 2.9, which is the highest, and it also has the highest number of tourists in hotels. The similar also applies to Salang which has the lowest in both. This positive correlation proves my hypothesis correct as the greater the bleaching, the lower the coral diversity as bleaching can kill off corals. The result is greatly significant statistically according to Mann-Whitney U test[3] with most data having less than 5% chance occurring by chance.

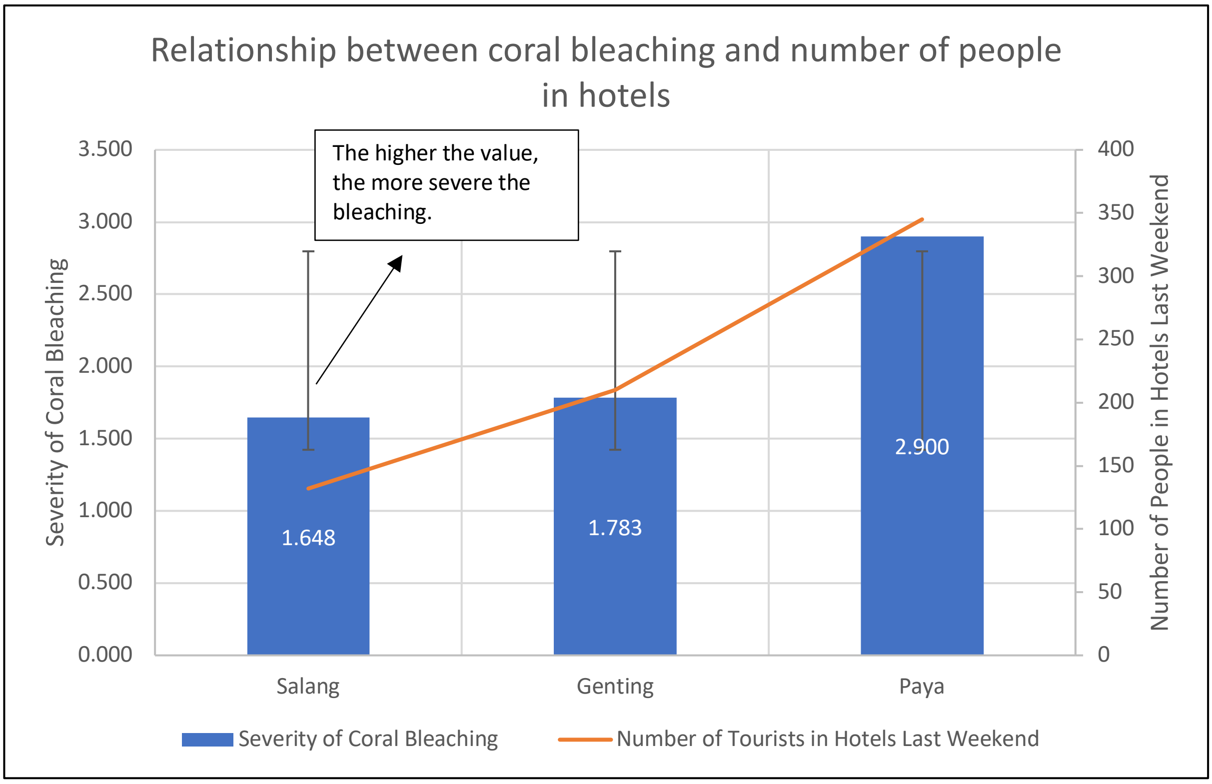

Figure 17 Combo graph. (Graph from author)

[3] Refer to appendix 3

Lastly, this hypothesis is also supported with the substrate data. Figure 18 shows that has the most hard corals, with an average 5.6 as compared to Paya with only 4.2, the least among all sites. Hard corals suggest healthy corals, thus its numbers correlates positively with the diversity of corals, as places with healthy corals often can support a higher variety of corals. Conversely, rubble suggests dead corals. Paya and Salang both have 5 rubbles on average. This contradicted with the hypothesis since Salang should not have as many rubbles as Paya since Salang has the more coral diversity and hard corals. This anomaly may be caused by monsoon, which destroys corals, instead of by tourism on the island.

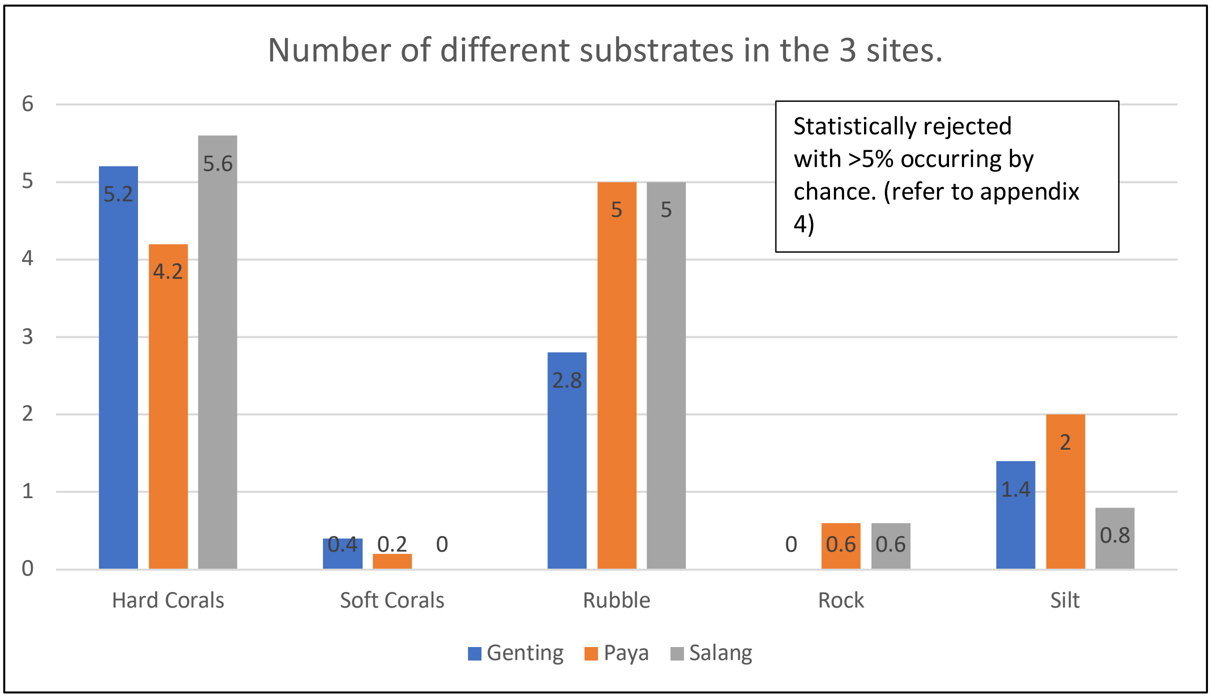

Figure 18 Mixed Bar graphs. (Graph from author)

Overall, the hypothesis is proven correct and statistically accepted. The result is also supported through various supporting data. Some of those data may not be statistically significant, thus making them redundant, but the general trend still supports the hypothesis.

Conclusion

The aim of this investigation is to examine the impact of tourism on the coastal environments of Tioman. The first hypothesis is proved correct with limited evidence showing that there is a positive correlation between the amount of tourist's land use and the amount of beach litter, as there is an anomaly in one site which, however, can be disregarded due to low significance statistically. Similarly with second hypothesis, it is proved correct with a weak negative correlation between the number of people in hotels and the coral diversity, as there are anomalies as well as a few supporting data being statistically insignificant. Nevertheless, the overall trends from supporting graphs are sufficient to support the hypotheses. All in all, it can be concluded that tourism has negatively impacted the coastal environments of Tioman Island.

Evaluation

The data collection was done during Ramadan, when tourism was at its lowest. This resulted in some skewed data, because the impact of tourism may be less significant than the locals'. Therefore, doing the study during a holiday season may result in less anomalies, especially in beach litter and tourists data.

Despite the methodology for collecting reefs data allows averages to be calculated, the monsoon season may affect the validity of the data as some damages done to the reef could be of natural causes instead of tourism. This can be improve by doing it in dry seasons, which would yield data with less non-human influences. Also, it was only possible to do one set of transect due to time constraints, but it will be helpful to do another set of transects at another spot near the jetty in each site. This will allow for more reliable data average. Also, data was collected in pairs, so it is possible that there were repetitions in the data as the pair had to swim close together for safety reasons, thus may record the same thing. Ideally, this could be improved by having each pair swam further apart so more areas could be covered, and less repetitions would occur. The tide also made it harder for the transects to be in a perfect straight line, thus resulting in possible repeated data as well. This, however, can only be compensated via finding an average of the data.

Tourists count data may be inaccurate since the visit to different sites occurred at different times of the day. Ideally, the data should be collected at each site at the same time, which would yield a more accurate data since there were certain times where there would be less tourists due to hot weather. Also, land use data may be inaccurate due to different interpretations of the methodology, as it was not specified which area should the land use be collected at each interval. This inconsistency may result in unreliable data, but this can be improved through specifying the methodology in clearer details.

Presentation of data can be improved by creating scatter graphs showing relationship between two variables with a single line of best fit to make it easier to understand. This is impossible due to the limited amount of data collected, so it will be helpful to carry out the study over a longer period, which also allows for more reliable data.

The fieldwork question can be improved by using a more specific terminology like "unsustainable tourism", which would help to make the investigation more specific. Therefore, if only sites that are unsustainable are chosen, the negative impact of tourism can be more easily observed, thus offering a more accurate conclusion to the investigation.

Acknowledgements

I would like to thank Mr Nicolson for his guidance throughout the entire process of the IA, and I would also like to thank field staffs from Ecofield Trip for organising and leading the data collection field trip.

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Appendix

		Plastic	Wood	Others	Total
Observed	Genting	5	2	4	11
	Paya	2	0	12	14
	Total	7	2	16	25

		Plastic	Wood	Others	Total
Expected	Genting	3.08	0.88	7.04	11
	Paya	3.92	1.12	8.96	14
	Total	7	2	16	25

CHI2 VALUE 3% Insignifance

		Plastic	Wood	Others	Total
Observed	Genting	5	2	4	11
	Salang	6	3	23	32
	Total	11	5	27	43

		Plastic	Wood	Others	Total
Expected	Genting	2.81395349	1.27906977	6.90697674	11
	Salang	8.18604651	3.72093023	20.0930233	32
	Total	11	5	27	43

CHI2 VALUE 11% Insignifance

		Plastic	Wood	Others	Total
Observed	Paya	2	0	12	14
	Salang	6	3	23	32
	Total	8	3	35	46

		Plastic	Wood	Others	Total
Expected	Paya	2.43478261	0.91304348	10.6521739	14
	Salang	5.56521739	2.08695652	24.3478261	32
	Total	8	3	35	46

CHI2 VALUE 43% Insignifance

Appendix 1 Chi-squared statistical test for Beach Litter

Site	**No. of damage**	**Ranking**
Genting	1	1.5
Genting	1	1.5
Genting	2	3
Genting	6	7.5
Genting	7	9.5
Paya	4	4.5
Paya	4	4.5
Paya	5	6
Paya	6	7.5
Paya	7	9.5

Genting		Paya	
No. of damage	Ranking	No. of damage	Ranking
1	1.5	4	4.5
1	1.5	4	4.5
2	3	5	6
6	7.5	6	7.5
7	9.5	7	9.5
T	**23**	**Tx**	**32**

n1n2	25	
nx(nx+1)/2	15	8
Tx	32	U value = 8
		critical value is 2
		Statistically insignificant

Site	**No. of damage**	**Ranking**
Genting	1	1.5
Genting	1	1.5
Genting	2	3
Genting	6	9
Genting	7	10
Salang	3	4.5
Salang	3	4.5
Salang	4	6.5
Salang	4	6.5
Salang	5	8

Genting		Salang	
No. of damage	Ranking	No. of damage	Ranking
1	1.5	3	4.5
1	1.5	3	4.5
2	3	4	6.5
6	9	4	6.5
7	10	5	8
T	**25**	**Tx**	**30**

n1n2	25	10
nx(nx+1)/2	15	U value = 10
Tx	30	critical value is 2
		Statistically insignificant

Site	**No. of damage**	**Ranking**
Paya	4	4.5
Paya	4	4.5
Paya	5	7.5
Paya	6	9
Paya	7	10
Salang	3	1.5
Salang	3	1.5
Salang	4	4.5
Salang	4	4.5
Salang	5	7.5

Paya		Salang	
No. of damage	Ranking	No. of damage	Ranking
4	4.5	3	1.5
4	4.5	3	1.5
5	7.5	4	4.5
6	9	4	4.5
7	10	5	7.5
Tx	**35.5**	**T**	**19.5**

n1n2	25	
nx(nx+1)/2	15	4.5
Tx	35.5	U value = 4.5
		critical value is 2
		Statistically insignificant

Appendix 2 Mann-Whitney U statistical test for Damage

Site	Coral Bleachi	Ranking
Genting	1.583	1.5
Genting	1.917	4
Genting	1.583	1.5
Genting	2.617	6
Genting	1.667	3
Paya	2.278	5
Paya	2.945	8
Paya	3.055	9
Paya	2.888	7
Paya	3.335	10

Genting		Paya	
Coral Bleaching	Ranking	Coral Bleaching	Ranking
1.583	1.5	2.278	5
1.917	4	2.945	8
1.583	1.5	3.055	9
2.617	6	2.888	7
1.667	3	3.335	10
T	**16**	**Tx**	**39**

n1n2	25	
nx(nx+1)/2	15	1
Tx	39	U value = 1
		critical value is 2
		Statistically Significant

Site	Coral Bleachi	Ranking
Genting	1.583	3.5
Genting	1.917	9
Genting	1.583	3.5
Genting	2.617	10
Genting	1.667	5
Salang	1.74	6
Salang	1.83	7
Salang	1.89	8
Salang	1.56	2
Salang	1.22	1

Genting		Salang	
Coral Bleaching	Ranking	Coral Bleaching	Ranking
1.583	3.5	1.74	6
1.917	9	1.83	7
1.583	3.5	1.89	8
2.617	10	1.56	2
1.667	5	1.22	1
Tx	**31**	**T**	**24**

n1n2	25	9
nx(nx+1)/2	15	U value = 10
Tx	31	critical value is 2
		Statistically Insignificant

Site	Coral Bleachi	Ranking
Paya	2.278	6
Paya	2.945	8
Paya	3.055	9
Paya	2.888	7
Paya	3.335	10
Salang	1.74	3
Salang	1.83	4
Salang	1.89	5
Salang	1.56	2
Salang	1.22	1

Paya		Salang	
Coral Bleaching	Ranking	Coral Bleaching	Ranking
2.278	6	1.74	3
2.945	8	1.83	4
3.055	9	1.89	5
2.888	7	1.56	2
3.335	10	1.22	1
Tx	**40**	**T**	**15**

n1n2	25	
nx(nx+1)/2	15	0
Tx	40	U value = 0
		critical value is 2
		Statistically Significant

Appendix 3 Mann-Whitney U statistical Test for Coral Bleaching

Observed		HC	SC	RB	RC	SI	Total
	Genting	5.2	0.4	2.8	0	1.4	9.8
	Paya	4.2	0.2	5	0.6	2	12
	Total	9.4	0.6	7.8	0.6	3.4	21.8

Expected		HC	SC	RB	SI	RC	Total
	Genting	4.225688073	0.269724771	3.506422018	0.269724771	1.528440367	9.8
	Paya	5.174311927	0.330275229	4.293577982	0.330275229	1.871559633	12
	Total	9.4	0.6	7.8	0.6	3.4	21.8

86% Insignifance

Observed		HC	SC	RB	RC	SI	Total
	Salang	5.6	0	5	0.6	0.8	12
	Paya	4.2	0.2	5	0.6	2	12
	Total	9.8	0.2	10	1.2	2.8	24

Expected		HC	SC	RB	RC	SI	Total
	Salang	4.9	0.1	5	0.6	1.4	12
	Paya	4.9	0.1	5	0.6	1.4	12
	Total	9.8	0.2	10	1.2	2.8	24

92% Insignifance

Observed		HC	SC	RB	RC	SI	Total
	Genting	5.2	0.4	2.8	0	1.4	9.8
	Salang	5.6	0	5	0.6	0.8	12
	Total	10.8	0.4	7.8	0.6	2.2	21.8

Expected		HC	SC	RB	RC	SI	Total
	Genting	4.86	0.18	3.51	0.27	0.99	9.8
	Salang	5.94	0.22	4.29	0.33	1.21	12
	Total	10.8	0.4	7.8	0.6	2.2	21.8

81% Insignifance

Appendix 4 Chi-squared statistical Test for Substrate