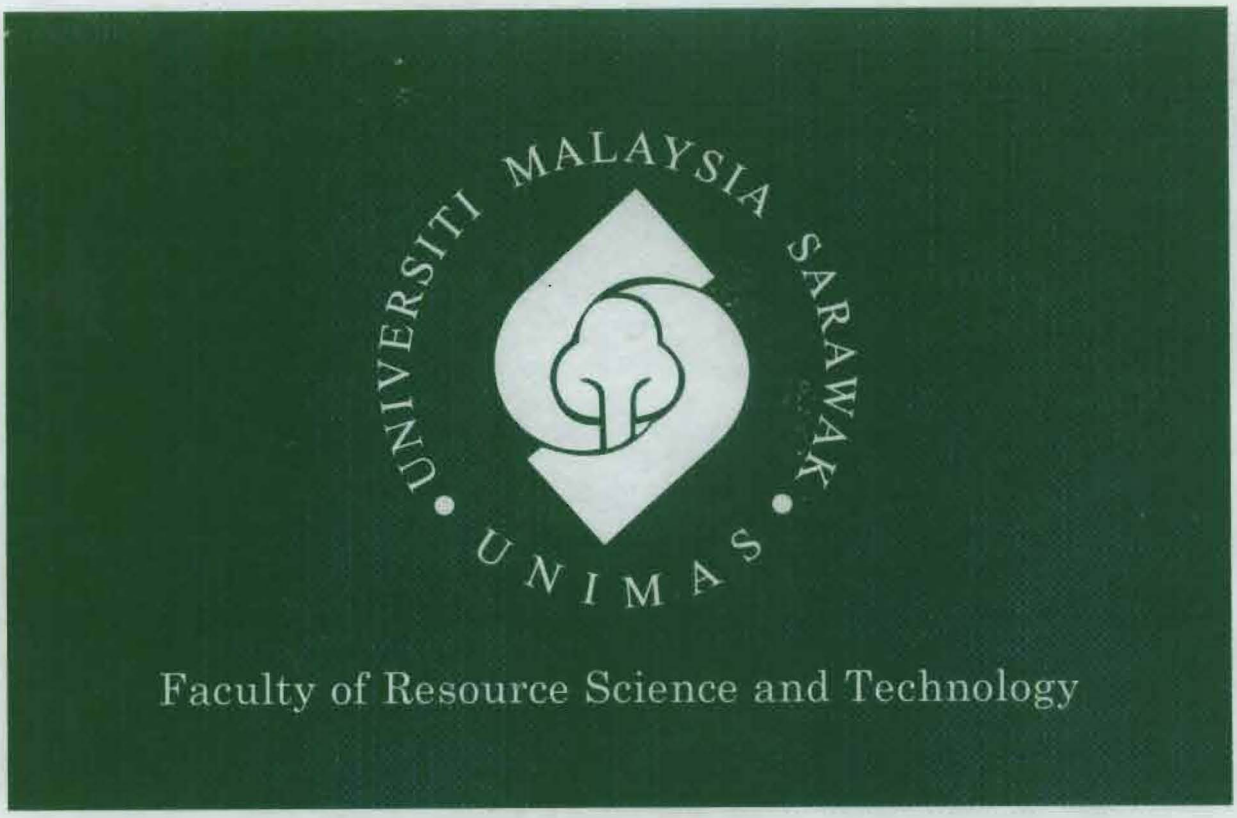

Assessment of Marine Debris at Tanjung Lobang Beach Miri, Sarawak during the Southwest Monsoon and Northeast Monsoon

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Bachelor of Science with Honours
(Aquatic Resource Science and Management)
2016

UNIVERSITI MALAYSIA SARAWAK

Grade: A

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Final Year Project Report ☑

Masters ☐

PhD ☐

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Assessment of Marine Debris at Tanjung Lobang beach Miri, Sarawak during the Southwest Monsoon and Northeast Monsoon.

Adriana Christopher Lee

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This dissertation is submitted in partial fulfillment of requirement for the degree of Bachelor Science with Honour in Aquatic Resource Science and Management

Faculty of Resource Science and Technology

UNIVERSITI MALAYSIA SARAWAK

2016

DECLARATION OF AUTHORSHIP

I, Adriana Christopher Lee, declare that the final year project entitled:

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Signed: 

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Date: 17 June 2016

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LIST OF ABBREVIATIONS

BEACON	Biodiversity, Environment and Conservation
GPS	Global Positioning System
kg	Kilogram
km	Kilometre
m	Metre
MEDPOL	Programme for the Assessment and Control of Marine Pollution in the Mediterranean
MLNG	Malaysia Liquified Natural Gas
MPAs	Marine Protected Areas
NEM	Northeast Monsoon
NWHI	Northwestern Hawaiian Islands
PAM/MAP	Mediterranean Action Plan
PNUE/UNEP	United Nations Environment Programme
SPSS	Statistical Package for the Social Sciences
SWM	Southwest Monsoon

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Assessment of Marine Debris at Tanjung Lobang beach Miri, Sarawak during the Southwest Monsoon and Northeast Monsoon

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ABSTRACT

Marine debris is a persistent problem along shorelines, coastal waters, estuaries, and oceans worldwide. Documentation on marine debris in Sarawak are available related to type and abundance of marine debris in Pandan (Lundu), Pasir Pandak (Santubong), Temasyah (Bintulu) and Tanjung Lobang (Miri) during the Northeast monsoon (NEM) and Southwest monsoon (SWM) before the development occur at the beach. This study was carried out to assess marine debris at Tanjung Lobang beach Miri, Sarawak during two monsoon seasons, the NEM and Southwest Monsoon (SWM) and to document beach user's perception on marine debris problems. This study recorded 3,235 items/km (234.5 kg/km) and 3,645 items/km (859 kg/km) for SWM and NEM, respectively. Plastic-based debris were the most numerous amounting to 1,191 items (86.56%) followed by timber, glass, rubber, metal, and cloth categories. Objects related directly with common source were 69%, whereas those from land-based and ocean-based sources amounted to 21.08% and 9.91%, respectively. Total marine debris item was more abundant during NEM (729 items) compared to SWM (647 items) seasons. For beach user's perception interview, about 71% respondent agreed that most marine debris came from irresponsible beach visitors. More awareness campaigns, beach cleaning activities and continuous monitoring of marine debris are crucial to enhance the concerns for marine environment conservation.

Keywords: Marine debris, marine debris type, marine debris source, monsoon, perception

ABSTRAK

Debri marin adalah satu masalah yang berterusan di sepanjang garis pantai. perairan pantai, muara, dan lautan di seluruh dunia. Dokumentasi mengenai debri marin yang boleh didapati di Sarawak adalah yang berkaitan dengan jenis dan jumlah debri marin di Pandan (Lundu), Pasir Pandak (Santubong), Temasyah (Bintulu) dan Tanjung Lobang (Miri) semasa monsun Timur Laut (MTL) dan monsun Barat Daya (MBD) iaitu sebelum pembangunan dijalankan di pantai tersebut. Oleh itu, kajian ini dijalankan untuk menilai debri marin di pantai Tanjung Lobang Miri, Sarawak pada dua jenis musim monsun iaitu MBD dan MTL serta untuk mendokumentasikan persepsi pengunjung pantai tentang masalah debri marin di pantai tersebut. Kajian ini mencatatkan jumlah debri marin sebanyak 3,235 item/km (234.5 kg/km) semasa MDB dan 3,645 item/km (859 kg/km) semasa MTL. Kategori plastik mencatatkan jumlah paling tinggi iaitu sebanyak 1,191 item (86.56%) diikuti dengan kategori kayu, kaca, getah, logam dan kain. Objek yang berkaitan secara langsung dengan sumber biasa ialah 69%, manakala objek dari sumber darat dan sumber laut berjumlah 21.08% dan 9.91%. Jumlah debri marin semasa MTL (729 item) lebih tinggi berbanding MDB (647 item). Bagi temuramah tentang persepsi pengunjung pantai, kira-kira 71% responden bersetuju bahawa kebanyakan debri marin datang dari pengunjung yang tidak bertanggungjawab. Memperbanyakkan lagi kempen kesedaran, aktiviti pembersihan pantai dan pemantauan yang berterusan mengenai debri marin adalah penting untuk meningkatkan kesedaran orang ramai mengenai pemuliharaan alam marin.

Kata kunci: *Debri marin, jenis debri marin, sumber debri marin, monsoon, persepsi*

1.0 INTRODUCTION

Marine debris is defined by the United Nations Environment Programme (UNEP) as any persistent, manufactured or processed solid material discarded, disposed or abandoned in the marine and coastal environment (Butterworth *et al.,* 2012). There are various types of marine debris such as plastic, rubber, metal, glass, timber and cloth following Ribic (1998). The main type of marine debris worldwide is plastic and the total amount recorded ranged about 60% to 80% from the overall marine debris (Derraik, 2002; Gregory and Ryan, 1997).

The sources of marine debris can be either from land-based, ocean-based and common sources. Marine debris from land-based sources are blown into the sea, and washed or dumped into the sea. Marine debris from ocean-based sources originated from boats, ships and offshore industrial platforms being washed to the beach (Sheavly, 2005). Common sources refer to objects that can be originating from either terrestrial or marine sources (Mobilik *et al.,* 2014). About 80% of marine debris are washed off from land, blown by winds, or deliberately discarded from shore and 20% originates from vessels and offshore platforms (Group of Experts on the Scientific Aspects of Marine Pollution, 1991). There are many harmful impacts of marine debris such as economic loss, habitat damage, wildlife entanglement and ingestion and transport alien species. In the Northwestern Hawaiian Islands Marine National Monument (NWHI), high rates of entanglement of wildlife have been documented among seals, sea lions and turtles (Henderson, 1984, 2001). However, there is still a positive impact of marine debris which it can generate money for those who are creative and love to make something useful from the marine debris.

Based on Mobilik *et al.* (2014), Sarawak is the largest state in Malaysia has approximately 1,035 km of coastline facing the South China Sea stretching from Tanjung Dato, Sematan to Merapok, Lawas (Department of Irrigation and Drainage Malaysia, 2012).

This coastline has many natural characteristics such as lagoon, mangrove forest, mudflats, swamps, rocky cliffs, sandy beaches and coral reefs (Hassan *et al.*, 2007). The high shipping traffic in the South East Asia region and the monsoon season becomes an efficient carrier of floating marine debris from the neighbouring country to the Malaysian marine environment. There are two types of monsoon regimes in Malaysia which are the SWM which occurs between May and September that typically signifies relatively drier weather. NEM occurs between November and March which brings heavy rainfall (Malaysian Meteorological Department, 2013).

Mobilik *et al.* (2014) had reported that marine debris at Tanjung Lobang beach recorded 665 item/km (35.8 kg/km) comprising plastic, rubber, metal, glass, timber and cloth. This data is considered as preliminary data as his study was done during the NEM season in 2012 which was before the development occur in Tanjung Lobang beach. The area has been developed to include amenities such as fast food restaurant, mini children playground and picnic areas in 2013, hence it supports a relatively larger volume of visitors compared to 2012 and this may influence the types and abundance of marine debris. Thus, this study was carried out to assess the marine debris at Tanjung Lobang beach during SWM (August 2015) and NEM (February 2016). The objectives of the study are: (1) to identify the type, abundance, sources and origin of marine debris at Tanjung Lobang beach during SWM and NEM and (2) to document beach user's perceptions on marine debris problems at Tanjung Lobang beach.

2.0 LITERATURE REVIEW

2.1 Definitions of marine debris

UNEP (United Nations Environmental Programme) defined marine debris as any persistent, manufactured or processed solid material discarded, disposed of, or abandoned in the marine and coastal environment (Butterworth *et al.,* 2012). Galgani *et al.* (2013) stated that marine debris composed of items that have been made or used by people and intentionally discharged or unintentionally lost in the sea or on beaches as well as the items transported from land into the marine environment by rivers, run-offs, sewage systems or winds. Although there are global treaties and enormous efforts in both developed and developing countries to protect the water quality, marine debris is usually an underestimated source of marine pollution and its amount continue to increase (Hofer, 2008).

2.2 Previous study related to marine debris

A study of type and abundance of marine debris at selected public beaches in Sarawak, East Malaysia during the NEM had been carried out to assess the amount of debris on selected public beaches, to categorize the debris by type of material and to determine the possible sources by Mobilik *et al.* (2014). The study was carried out in October 2012 during NEM which brings heavy rainfall. One of the selected public beaches was Tanjung Lobang. Based on the study, the greatest amount of marine debris collected at Tanjung Lobang beach was plastic (587 item/km) followed by the timber (56 item/km), rubber (11 item/km), metal (6 item/km), glass (4 item/km) and cloth (1 item/km) was found.

The number of items collected at Tanjung Lobang beach was 665 items/km which was the second highest among the four public beaches examined in their study. However,

the total weight of the items was 35.8 item/km which was the lowest among the four public beaches. Then, the data were compared to the previous study conducted at the same location in February 2008 by Hassan & Mobilik (2012) and it showed that the amount of debris in Tanjung Lobang decreased from 1178 item/km in 2008 to 665 item/km in 2012 most probably due to the effort of the Malaysian government in controlling solid waste through the Solid Waste and Public Cleansing Management Act (2007). According to Khairunnisa *et al.* (2012); Hassan *et al.* (2007); Sheavly (2005), proximity to the urban centres, development areas, industrial and recreational areas also influence the types and abundance of marine debris present in the marine environment.

2.3 Types and classification of marine debris

The most common types of marine debris are plastic, rubber, metal, glass, timber and cloth (Lippiatt *et al.,* 2013; Sheavly, 2007). Plastic include ropes, fishing lines, lighters and microplastic fragments. Rubber include footwear, tyres, balloons and gloves. Metal include tin cans, aerosol cans, metal drums and aluminium cans. Glass include jars, light bulbs and bottles. Wood include cardboard cartons, pallets and crates. Cloth include shoes, furnishings and towels (Himans, 2013). The majority type of marine debris that can be found all over the world is plastic. Plastic is a synthetic polymer that comes in variety shapes, sizes, and colours. According to Derraik (2002), plastics usually make up 60% to 80% of total marine debris.

Every piece of debris should be recorded according to material category and then by specific item or product (Ribic *et al.*, 1992). Another way to classify marine debris is by the type of activity that produced the waste item and the associated actions that caused the waste to become marine debris (Sheavly, 2007). Marine debris sources also can be classified either

land-based, ocean-based and common sources depending on how the debris enters the marine environment. The origin of debris can be identify either from local and foreign country based on the information on the debris such as barcodes and manufacturer's address.

2.4 Sources and origin of marine debris

The sources of marine debris can be divided into three which are the land-based sources, ocean-based sources and common sources (Table 2.1). Marine debris from land-based sources are the debris blown into the sea, washes into the sea or discharged into the sea (Sheavly, 2005). Land-based sources are responsible for up to 80% of marine debris and the remainder 20% was due to ocean-based activities (Sheavly, 2005; Allsopp *et al.*, 2006). PNUE/PAM/MEDPOL (2009) reported that most marine litter in the Mediterranean Sea comes from land-based sources rather than ocean-based sources. Examples of land-based sources are storm water discharges, combined sewer overflow, littering, solid waste disposal and industrial activities.

Ocean-based sources refers to all forms debris from boats and ships and offshore industrial platforms are significant sources of marine debris. The debris may come from accidental loss, random littering, illegal disposal or the outcome of waste management disposal practices that had been carried out in the past (Sheavly, 2005). Marine debris is light weighted so it could travel far in the sea and it degrades gradually in the marine environment (Mobilik *et al.* 2014). A hectic maritime traffic area or where the ocean currents naturally accumulate surface material also could gather high amount of marine debris (Walker *et al.*, 1997). Other examples of ocean-based sources are commercial fishing, recreational boaters, merchant, military and research vessels and platforms of offshore oil and gas exploration (Allsopp *et al.*, 2006). Common sources referred to objects that could originate from either

land-based or ocean-based sources (Mobilik *et al.* 2014). According to Australian and New Zealand Environment and Conservation Council (1996), the sources of the debris must be known before taking any actions to decrease marine debris in the marine environment. Enforcement of rules need to be enhanced to boost consciousness on the importance of the marine environment (Mobilik *et al.* 2014).

Table 2.1: Sources of marine debris items following Ribic (1998) and Wace (1995). (Source: WWF 2006)

Ocean-based sources	Land-based sources	Common sources
Aerosol cans	Aluminum cans	Colored plastic bottles
Baskets and buckets	Baby care items	Glass bottles
Cigarette lighters	(including disposable nappies,	Tooth and hair brushes
Fishing line	milk bottles and milk formula	Clear plastic bottles
Fishing nets	spoons)	Plastic bottle tops
Foam cups	Cardboard drink cartons	
Foam insulation	Children's toys	
Foam packaging	Cloth and clothing	
Fodder bags	Food wrappers	
Fuel pumps	Footwear (rubber thongs)	
Gloves	Medical waste	
Hard hats	Paper and cardboard	
Ice bags	Shopping bags	
Light globes/tubes	Six pack rings	
Lures	Steel food tins	
Net floats and buoys		
Oil bottles		
Pallet wrappers		
Potable water filters,		
Ropes		
Scrubbing brushes		
Steel drums		
Strapping bands		

The origin of the marine debris can be identified based on manufacturers, inscriptions and barcodes on the marine debris (Kiessling and Hamilton, 2003). According to White (2005), product names, manufacturers or barcodes on the debris item are the details about the debris. Some items would be too seriously weathered for any details to be recorded but

when carefully inspected many will have held some details. Based on White (2005), barcodes were found on most items and it is one of a very helpful detail to record during marine debris study. The important numbers are the first three digits because these three numbers are unique to every country and give a good clue of where the item was sold. The combination of manufacturer's details and barcodes are a great way to identify the origin of the item and ought to give a better clue of whether the general debris is originating from local or foreign sources (White, 2005).

2.5 Marine debris from the river

Marine debris can originate from the river. This is known as riverine debris which caused by direct dumping at riversides, discharge from boats, urban and rural run-off and effluents from sewage plants (Williams and Simmons, 1997). Riverine debris can move to the sea and end up on coastal beaches (Acha *et al.*, 2003) and the seafloor (Galgani *et al.*, 2000). Globally, about 80% of solid marine debris comes from the closest rivers (Araújo and Costa, 2007). Thus, rivers are usually recognized as the main source of debris on coastal beaches (Williams and Simmons, 1997). This pattern was confirmed by the studies based on debris samples in urban rivers (Moore *et al.*, 2011; Carson *et al.*, 2013). Factors manipulating riverine debris transport patterns are the river's flow rate, the occurrence of bottom currents and the presence of submarine river extensions (Galgani *et al.*, 2000). High river run-off after storms and heavy rainfalls also lead to the deposition of debris at far distances from the river mouth (Moore *et al.*, 2002).

The transportation and deposition patterns of floating debris in coastal zones are influenced wind, nearshore currents, wave motion and tidal dynamics (Browne *et al.*, 2010) and the geomorphology of the shoreline (Araújo and Costa, 2007). The abundance and

composition of debris in rivers, at riversides and on beaches is influenced by land use and social or economic activities in the coastal or river area (Williams and Simmons, 1999; Shimizu *et al.,* 2008). The abundance of persistent buoyant debris items on coastal beaches should decline with the increase distance from a river mouth. The patterns of abundance of these debris items on coastal beaches near the river mouth are related with directions of coastal winds or water currents (Rech *et al.,* 2014).

2.6 Threats and impacts

Marine debris can have critical impacts on marine wildlife, humans, ecosystem and beaches. Entanglements in marine debris leads to suffering of wildlife which eventually killed thousands of marine wildlife and birds every year. The entanglement of fish, turtles, birds and marine mammals was mainly caused by the discarded and missing fishing gear, ropes, nets and plastic wrappers. About 136 of marine species have been reported entangled which included 6 species of sea turtles, 51 species of seabirds and 32 species of marine mammals (Marine Mammal Commission, 1996).

The animals also mistaken some of marine debris for food and once ingested, these materials caused starvation and choking in animals such as seals, sea lions, seabirds and sea turtles (Marine Debris and MPAs, 2011). For example, sea turtles could mistaken plastic bags for jellyfish and birds can mistaken pieces of plastic bag as their prey (Marine Debris and MPAs, 2011; Butterworth *et al.,* 2012). In 2010, in the stomach of a dead gray whale on a beach in United State, there were found a golf ball, tape, surgical gloves, small towels, sweatpants and over 20 plastic bags (Marine Debris and MPAs, 2011).

Marine debris also can be a health and safety hazard for humans. Broken glass, medical waste, rope and fishing line can directly harms human health and safety because

sharp objects such as broken glass and rusty metal could cause injuries to the beach's user (Himans, 2013). Marine debris can wrap around and damage the boats and vessels propeller debris and cause a serious impact on economic activity such as tourism (Potts & Hastings, 2011).

Marine habitat such as coral reefs that act as the basis of marine ecosystems and are important to the survival of many other species can be damaged because marine debris can entangle the branching species of corals causing in fragmentation and abrasion (US Environmental Protection Agency, 2011). According to Sheavly (2005), ropes and nets can break and wipe out corals when shifted by currents and tides.

Marine debris also can transport alien species which the alien species can attach to the marine debris and it can travel hundreds of miles and land on a shoreline where it is non-native. This alien species can have a catastrophic impact on fisheries and local ecosystems and very damageable (Allsopp *et al.*, 2006).

However, marine debris also have a positive impact to some people who loves to collect and recycle the marine debris into something useful. They can make money by selling these items to other people.

2.7 Marine debris awareness

There were various activities done by government and non-government sectors to protect the beaches in Malaysia. Malaysia Liquified Natural Gas (MLNG) Sdn Bhd's Biodiversity, Environment and Conservation (BEACON) programme conducted a beach cleaning activity at Similajau National Park on 5th September 2015 for two days which involved about 200 volunteers to generate more awareness among the community not to treat the sea as a dumping ground (Malaysia LNG Group of Companies Newsroom, 2015).

Besides that, Volunteer Malaysia 2015 is a programme organised by iM4U supported by the Ministry of Tourism and Culture. The programme which took place nationwide 12th September involved more than 20, 000 volunteers participating in the four main activities and one of the activities was Beach and Underwater Clean Up which is a collaborative effort to protect the country's waterway and the ocean from pollution (Ringgit, 2015). Apart from that, Media Prima also conducted a Beach Cleaning Program at Pulau Tioman on 2011 (Media Prima, 2011).

Other effort such as No Plastic Day campaign by supermarkets and grocery stores in Malaysia is conducted to reduce plastic bag use and to save the environment (Zen *et al.*, 2013). The Malaysian Insider (2015) reported that the Urban Wellbeing, Housing and Local Government ministry announced that they will implement the mandatory household solid waste separation according to categories programme from September 2015 onwards to improve solid waste collection and management in the country and to reduce the amount of solid waste sent to waste disposal sites by 40%. The 3Rs (Reduce, Reuse, Recycle) programme is a programme that involved the Ministry of Housing and Local Government, local authorities, concessionary companies, collectors and manufacturers, non-governmental organizations, private residents associations, educational institutions, private waste recyclers and others to reduce the nation's generation of solid waste. The objective of this programme is the same with the National Recycling Target which 22% of the total solid waste can be recycled by the year 2020 (Agamuthu, 2011).

2.8 Monsoon seasons and tides

There are two types of monsoon regimes in Malaysia which are the Southwest monsoon (SWM) and Northeast monsoon (NEM). SWM occurs between May and

September typically signifies relatively drier weather and less rainfall. NEM occurs between November and March that brings heavy rainfall (Malaysian Meteorological Department, 2013). Monsoon is caused by land-sea temperature differences due to heating by the sun's radiation. The transition period in between the monsoons is known as the intermonsoon period which takes place from April to May and from September to October. During the intermonsoon periods, the winds are generally light and variable (Malaysian Meteorological Department, 2013).

According to Malaysian Meteorological Department (2013), for the rainfall distribution the seasonal wind flow patterns and the local topographic components determine the rainfall distribution patterns over the nation. During the NEM season, western Sarawak experiencing heavy rainfall. There are seasonal variation of rainfall in Sarawak which the coastal areas of Sarawak receive a rainfall regime of one maximum and one minimum. Maximum rainfall in the coastal areas of Sarawak happens during January with minimum rainfall happens in June or July (Malaysian Meteorological Department, 2013). Under this regime, more rainfall is received during the NEM months of December to March and less rainfall is received during the SWM months of June to August which corresponds to the occurrence of prevailing southwesterly winds (Malaysian Meteorological Department, 2013). Based on interview with Captain Abdul Malik Hashim which is a Marine Superintendent done by Mobilik *et al.* (2014), it is generally agreed that monsoon season also becomes an efficient carrier of floating marine debris from the neighbouring country to the Malaysian marine environment.

Tides are generated when the Earth and the moon are attracted to each other (Cooley, 2002). The moon tries to pull at anything on the Earth to bring it closer but the Earth is able to hold onto everything except the water. The water is constantly moving so the Earth cannot

hold onto it so the moon is able to pull it. According to Cooley (2002), there are two high tides and two low tides every day. The ocean is constantly moving from high tide to low tide and vice versa. Approximately, there is 12 hours and 25 minutes between the two high tides (Cooley, 2002).

Tides are the periodic rise and falling of large bodies of water (Cooley, 2002). When the moon is full or new, the gravitational pull of the moon and sun are combined. During these times, the high tides are very high and the low tides are very low. This is known as a spring high tide. Cooley (2002) stated that, spring tides are particularly strong and occur when the Earth, the Sun, and the Moon are in a line. The gravitational forces of the Moon and the Sun both contribute to the tides.

During the moon's quarter phases, the sun and moon work at right angles cause the bulges to cancel each other. The result is a smaller difference between high and low tides and is known as a neap tide. Neap tides are particularly weak tides and occur when the gravitational forces of the Moon and the Sun are perpendicular to one another (Cooley, 2002).

2.9 Beach user's perception interview

Interviewing the beach user for their perception has increased in the last decades to know their behaviours, views and preferences. The analysis of beach user's perception is usually carried out using surveys based on standard questionnaires and interviews (Marin *et al.*, 2009). The user's profile is described together with their perceptions and preferences on several groups of aspects that are obtained through a detailed standard questionnaire. This method consists of a huge survey of beach user's profile and perception by using a questionnaire (Roca and Villares, 2008).