CHAPTER 1

INTRODUCTION

1.1 Introduction

In January 1975, approximately 4,000 tonnes of crude oil were spilled from the Japanese supertanker *Showa Maru*. The incident took place along the Strait of Malacca between Malaysia and Sumatra. It was the first recorded oil spill incident along the Strait (Control of oil spill in Malaysian water, n.d.).

In late 1997, the Chinese tanker *An Tai* which carried oil from the Middle East ran aground in the Strait, spilling 235 tonnes of crude oil that threatened to destroy the mangrove forests which lined the coasts of Perak and Selangor in the western part of Peninsular Malaysia. The length of coastline affected by the spill was approximately 250km (Zakaria et al., 2000).

Showa Maru and *An Tai* were not the only two oil spill incidents that occurred along the Strait of Malacca. According to data obtained from the Malacca Strait Research and Development Centre between 1978 and 1984, there were 476 shipping accidents, out of which 20.6% (98) involved oil tankers. From the graph obtained from Wang and Stout (2007), there is an obvious increase in the number of oil spills incidents from 1976 to 1996 (Fig 1.1). However, not all accidents were recorded as some smaller ones were not reported. Some of the larger oil spills resulting from accidents are shown in Table 1.1.

Occurrences of accidents cannot be predicted. Incidents similar to the above can occur along the Strait of Malacca again, as it is one of the busiest international shipping lanes (Ahmad and Hassan, 1983; Hii et al., 2009). Oil spills become a major concern of Malaysia (Sapari, 1987) as this country is surrounded by seas particularly, the seabed and marine environment of the Strait of Malacca and South China Sea.

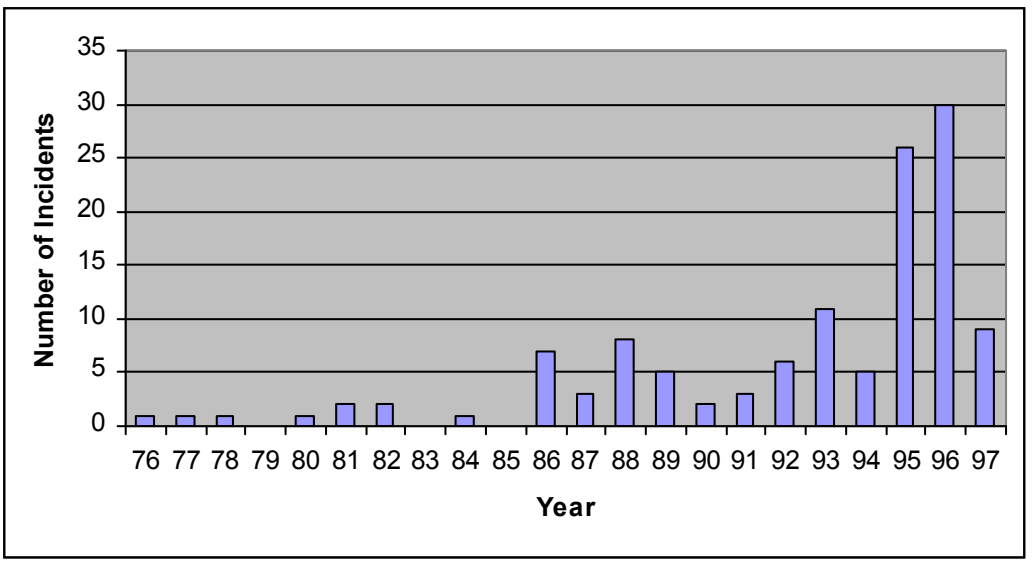

Figure 1.1: Oil spills incidents in the Strait of Malacca (Wang and Stout, 2007)

Table 1.1: Examples of oil tankers accidents in the Strait of Malacca obtained from Marine Department Malaysia.

Year	Name of ship	Cause	Type and Quantity of Oil Spill
1975	Showa Maru	Grounding	Crude oil 4000 tons
1976	Diego Silang	Collision	Crude oil 5500 tons
1977	Asian	Collision	Fuel oil 60 tons
1981	Mt Ocean Treasure	Human error	Fuel oil 1050 tons
1986	Bright Duke/ MV Pantas	Collision	-
1992	Nagasaki Spirit and Ocean Blessing	Collision	-
1997	Mt. Evoikos and MT. Orapin Global	Collision	-
1997	An Tai	Material Fatigue	Fuel oil 237 tons

Pulau Pangkor, an island in which its economy is tourism-based, is situated at the central-eastern part of the Strait of Malacca and is at a high risk of being polluted by oil spills originating from oil tanker accidents. With proper mitigating plans, the negative impact of an oil spill can be minimized.

1.1.1 Strait of Malacca as a maritime thoroughfare

In early 1982, the US Defence Mapping Agency identified the Strait as one of the most difficult navigational passages in the world due to shifting of sand bottom, tidal

ranges and strong tidal currents (Purwaka, 1998). The Strait is a funnel-shaped waterway with extremely contrasting physical features. The width of the Strait varies from less than 3 km at its narrowest passage between southern Sumatra and Singapore to about 350 km at its widest, between Northern Sumatra and Thailand, and extends to about 900km in length. At various locations, the depth of the Strait is quite shallow, at just 25 meters (Kuppuswamy, 2004). The challenging physical conditions of the Strait have contributed to ship groundings, vessel collisions and other navigational accidents particularly for deep-draft vessels such as Very Large Crude Carriers (also known as VLCC).

This Strait that separates Peninsular Malaysia from the island of Sumatra, Indonesia, is the main shipping channel between the Indian Ocean and the Pacific Ocean linking major Asian economies (Ahmad and Hassan, 1983; Samad and Mansor, 2002). Over half of the world's merchant fleets sail through Malaysian waters, making it one of the world's busiest international shipping lanes. About a quarter of the oil in the global market that is transported by sea passes through the Strait, mainly from Persian Gulf suppliers to Asian markets such as China, Japan and South Korea. In 2009, an estimated 13.6 million barrels per day were transported through the Strait (U.S. Energy Information Administration, 2010), exposing the water and shoreline of the Strait to a constant threat of oil spill incidents, particularly the beaches of Pulau Pangkor (Samad and Mansor, 2002). Pulau Pangkor, being an important tourist destination with its beautiful beaches and top class resorts needs to be protected from the threat of oil pollution.

Should there be a serious accident resulting in a major oil spillage in the near future, it could have catastrophic consequences on the coastal environments of Peninsular Malaysia. It is therefore important to assess and analyse the shorelines along the Strait for their vulnerability to oil spills so that contingency plans or priorities for the protection of various coastal ecosystems can be effectively set in place (Ng et al., 2008).

1.1.2 Definition of an oil spill and coastal facies

An oil spill is a release of a liquid petroleum hydrocarbon into the environment due to human activity, and is a form of pollution (Fig 1.2). The term often refers to marine oil spills, where oil is released into the ocean or coastal waters.

Figure 1.2: Example of an oil spill that polluted the beaches of Pengerang in southeast Johor, Malaysia, after an oil tanker and bulk carrier collided between Malaysia and Singapore spilling about 2 500 tons of oil into the sea on May 27, 2010 (Jakarta Globe, 2010).

The term "coast" means border of the land near the sea (Fowler and Fowler, 1990) and "facies" in geological term means the character of a rock and etc, expressed by its composition (Fowler and Fowler, 1990). Therefore in this thesis, coastal facies are referred as the different geomorphology of the land near the sea which is the island, Pulau Pangkor.

1.1.3 Effect of oil spills on beaches

Oils spills can contaminate a beach as they would be washed up to the beaches (Jalali et al., 1998) during high tide and left stranded on the beaches during the following low tide (Fig 1.3 and Fig 1.4). Oil would then start to penetrate the layers of beach sand once they come in contact with the beach sediment (Fig 1.5).

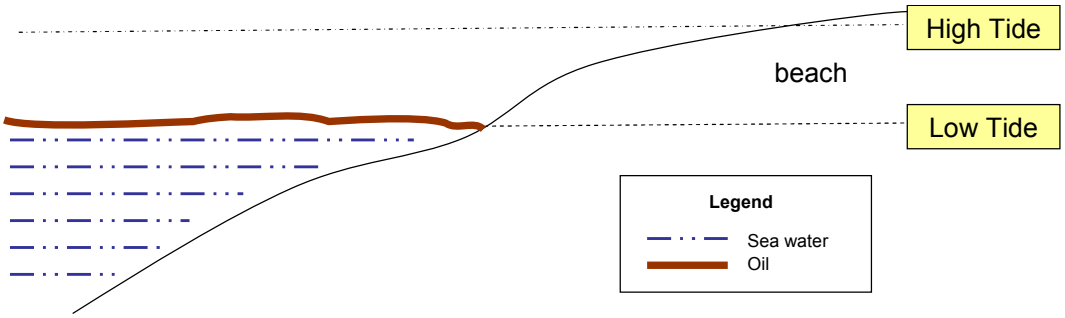

Figure 1.3: Oil slicks floating above sea water reach the coastal area at low tide.

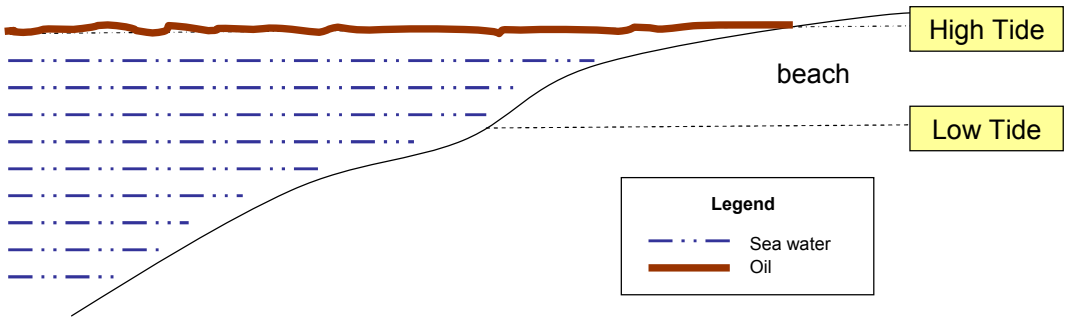

Figure 1.4: Waves wash oil slicks up to the beaches during high tide

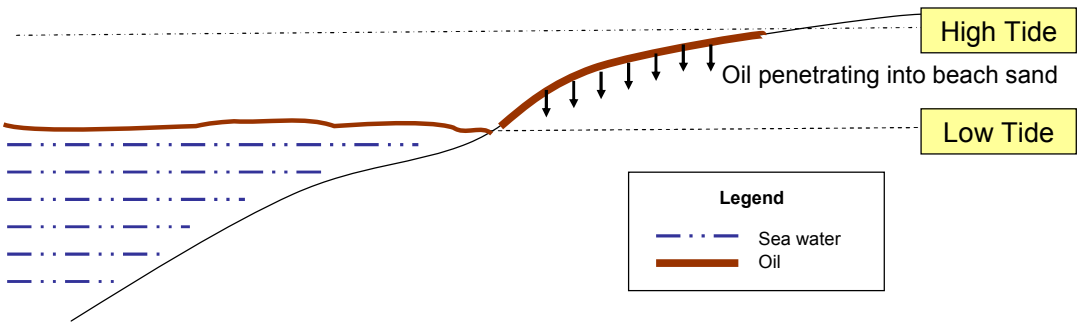

Figure 1.5: During the following low tide, the oil slicks would be left on the beaches and oil would penetrate into the beach sand.

Oil residues in sediment longer than in water and thus, leads to long-term hazards to the coastal environment (Hii et al., 2009). Oil spills are extremely destructive and could contaminate beaches to the point where they could not be used for recreational purposes. An example of a recent oil spill incident would be the Deepwater Horizon oil rig explosion in the Gulf of Mexico on 20 April 2010, where the oil slicks had covered more than 65 miles of the Louisiana shoreline just one month after the spill (Oil Reaches Louisiana Shores, 2010).

An oil spill reaching the coasts of Pulau Pangkor would likely have disastrous effects on the economy of the island. Not only would oil and tar-covered beaches keep tourists away, cleaning up the beaches would also necessitate costly efforts and would likely take days if not weeks. The ecosystem in the coastal areas would take months to restore even after the beaches have been cleaned (Schlacher et al., 2010).

An initial assessment of oil spill vulnerability of shorelines has been conducted by Ng et al. (2008) in Pulau Penang. This research addresses the issue in more detail by studying what would happen once oil reaches the beaches of Pulau Pangkor and proposes mitigating measures to protect these beaches from potential oil spills.

1.2 Problem Statement

The scenario stated above leads us to a number of questions that need to be addressed:

1. How would an oil spill reach the coast of Pulau Pangkor?
2. To what extent would the coast of Pulau Pangkor be affected by an oil spill?
3. How would each coastal facies be affected by an oil spill?
4. What can be done to minimize the impact of or prevent oil spills in Pulau Pangkor?

1.3 Objectives

1. To demarcate danger zones in the Strait of Malacca where any oil spills occurring in these zones would affect Pulau Pangkor.
2. To identify the various coastal facies of Pulau Pangkor and assess their vulnerability to oil spills.
3. To analyse the nature and composition of coastal facies sediments and assess the impact of pollution by oil spills on these facies.
4. To formulate mitigating measures that would help protect Pulau Pangkor.

1.4 Scope of Study

1. Satellite imagery was used to study the coastal environments of Pulau Pangkor and its vicinity and to identify and categorize its coastal facies and determine which facies would be most affected by potential oil spills. Satellite imagery was also used to collect oceanographic data such as wind, wave and current directions to demarcate the danger zones and routes of oil spills that would specifically reach Pulau Pangkor.
2. The various coastal facies were analysed in detail. This phase involved:
   (i) collecting sediment samples,
   (ii) analysing sediment composition under the microscope,
   (iii) sieving beach sediment samples to determine grain size distributions,
   (iv) dissolving samples with hydrochloric acid (HCl) to determine the proportion of carbonate sediments.

   These analyses were carried out to identify the nature of the sediments and the sources of their origin for each beach and to determine the direction and dynamics of beach sediment transport by currents and tides.
3. To assess the effect of pollution by oil spills in relation to the coastal facies and various types of sediments, undisturbed cores of beach sand were collected and the depth and duration of penetration by various grades of oil into the core sediments were measured.
4. The results of these investigations lead to the formulation of measures to mitigate pollution by potential oil spills.

1.5 Thesis Outline

This thesis consists of five chapters. Chapter 1 is the introduction with objectives of this study and problem statements that leads to the title of this thesis. Chapter 2 presents the literature review and previous work related to the title of thesis. Chapter 3 includes the study area which is Pulau Pangkor and the methodology being used in this research. Chapter 4 explains the results and discusses on the origin of oil spills,

and identifies the various coastal facies on Pulau Pangkor, followed by studies on the behavioral of oil on the various coastal facies of the island and the impact of oil spill towards these facies. Mitigating measures are suggested in this chapter as well. Chapter 5 is the conclusion of this research plus recommendations for further study.