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Contingency plan improvement for managing oil spills in the coastal waters of Thailand

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ABSTRACT

The estimated risks of being impacted by oil spills in the coastal waters were used to improve the oil spill contingency plan of Thailand. Functional roles of local agencies are integrated into the plan. Intensive measures are suggested for the coastal provinces located in high-very high risk zones, whereas light and moderate measures are suggested for the coastal provinces located in low and moderate risk zones, respectively. The estimated percentage risks due to simulated oil slicks hitting the coast and/or important resources ($PR_{oilspill}$) were used to guide the year-round water activities that should be carefully handled at a certain radius with a low-moderate $PR_{oilspill}$, whereas they should be avoided at a certain radius with a high-very high $PR_{oilspill}$. Important measures before, during, and post periods of an oil spill incident are suggested to prevent and monitor oil spill incidents and mitigate their impacts on the environment.

1. Introduction

An effective response to oil spills is dependent to a great extent on the preparedness of the organizations and individuals involved. This can be greatly enhanced by developing and maintaining a plan to address all likely contingencies. The process of producing a contingency plan provides an opportunity to identify roles and responsibilities and to define response strategies and operational procedures (ITOPE, 2011a). Currently, although many countries across the world have their own contingency plans (e.g., Froebe, 1985; El-Raey et al., 1996; Wirtz and Liu, 2006; Ruoppolo et al., 2013), it is rather difficult to prepare and maintain an efficient plan with a variety of decision responses to mitigate the impacts of oil spills on the environments, wildlife, fisheries, recreational activities, etc. In Thailand, oil spills have affected aquatic ecosystems, coastal resources, aquaculture, and tourism business leading to considerable damage to the socioeconomics and the ecological values of the country (Singkran, 2013).

During 1973–2013, a total 246 oil spill incidents were observed in Thailand and its proximity. Of these, 234 incidents occurred in coastal areas, 7 incidents occurred beyond a radius of 150 kilometers (km) from the coastline, 1 occurred beyond Thailand's marine territory, and 4 incidents occurred inland. The causes of oil spills were illegal discharge of wastewater contaminated with oil from boats into the sea (24.80%), boat accidents, crashes, or sinking (17.07%), impaired equipment for navigating vessels or storing/transferring oils (14.23%), oil shifted from ships to small boats in the open sea and from ships to ports (3.66%), others (14.63%), and unknown causes (25.61%; Marine Department, unpublished data). Most of the reported oil spill incidents occurred in the Upper Gulf of Thailand, especially along the main shipping routes and around the mouths of large rivers (e.g., the Chaopraya, Thachin, and Maeklong Rivers) located on the Bangkok Bight (Ivanov and Zatyagalova, 2008).

To tackle oil spill problems, the Thai government set up the National Oil Pollution Prevention and Elimination Committee (NOPEC) in 1982. Later, NOPEC prepared a national oil spill contingency plan on August 6, 2002, which has since been improved. The plan includes 3 major steps, i.e., oil spill elimination, operation completion, and damage claims (Fig. 1). First, anyone who observes an oil spill incident has to call the Marine Department's marine safety center by dialing 1199 (an emergency telephone number available 24 h a day). The marine safety center will call on NOPEC to manage the problem by cooperating with the coordination center (directed by the Director-General of Marine Department) and the operation control center (directed by a representative from the Marine Department or Royal Thai Navy). The director of the operation control center has authority to (1) assign operation center officials to cope with each oil spill incident, (2) finish the oil spill elimination operation, and (3) inform the coordination center. The second step, after being informed, the coordination center will ask for approval for the operation completion from NOPEC. For the last step, damage claims, the Marine Department will gather oil

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spill evidence to prosecute the oil spill polluter to pay for the oil spill elimination cost, whereas the Pollution Control Department and Office of Natural Resources and Environmental Policy and Planning will prosecute the oil spill polluter to pay for the environmental damage and recovery cost.

According to the national oil spill contingency plan of Thailand, 3 important aspects are considered in the process of oil spill prevention and elimination, i.e., operation goals, oil spill volume, and methods used. The goals are to (1) stop additional oil leakage from the spill sources, (2) monitor the trajectory and dispersion patterns of oil slicks for efficient management, (3) limit the expansion areas of oil spills, and (4) protect important resources and economic areas with high risk of being contaminated. Other than the geographic and environmental conditions of an area and the type and characteristics of spilled oil (Singkran, 2013), the volume of oil leakage is one of the key variables needing to be established when preparing an operation plan. Three sizes of oil leakage are assigned including tier 1: $x \leqslant 20{,}000$, where x = amount of oil leak in liters; tier 2: $20{,}000 < x \leqslant 1{,}000{,}000$; and tier 3: $x > 1{,}000{,}000$. At tier 1, oil leakage often occurs during transfer of the oil in port, and the case must be reported to the Marine Department (i.e., the NOEPC's coordination center), and the oil spill polluter must be responsible for the elimination of the oil spill with support from local governmental agencies if necessary. At tier 2, oil leakage often occurs due to boat crashes, and the case must be reported to the Marine Department. The agencies involved will be assigned for assisting the oil spill polluter to cope with the problem following the national oil spill contingency plan. A worse case may need additional support abroad in terms of spill elimination equipment. At tier 3, oil leakage is most likely to occur due to a severe boat accident, and NOPEC will assist the oil polluter to cope with the problem following the national oil spill contingency plan with support from other agencies inside the country and abroad.

Various methods of oil spill prevention and elimination have been proposed in the national oil spill contingency plan of Thailand depending on certain conditions. In the case of a small leakage amount, the oil spills may be left to self-degrade in a water source. However, the trajectory and dispersion patterns of oil slicks still have to be monitored. In case of high variations of waves, currents, and wind speed that obstruct the oil spill elimination operation, it may be better to leave the oil slicks to disperse onto shore, then the oil slick collection and cleaning process can be implemented. Gel or agglomeration substances may be useful for oil spill coagulation before collection.

Mechanical techniques such as booms may be employed to trap the oil slicks in the water; then skimmers with suction devices can be used to collect the oil slicks. This method has no side effects on nearby environments (El-Zahaby et al., 2011), but requires a site-specific understanding of the physical, biological, and social settings of the area and their influences on the weathering and fate of the spilled oil in the aquatic environment (IMO, 1995, 1997). The effectiveness of surrounding oil slicks mainly depends on (1) boom size and design, (2) type of the spilled oil, and (3) environmental conditions, e.g., water velocity and current, wind, wave, etc. (Fingas, 2011; ITOPE, 2011b). Meanwhile, the effectiveness of a skimmer to collect oil slicks depends on a number of factors, such as (1) viscosity and adhesive properties of the spilled oil and its fate and weathering over time, (2) sea state and levels of debris, and (3) type of a skimmer, a specific or versatile one (Fingas, 2011; ITOPE, 2012).

A proper dispersant may be used to disperse the slicks of spilled oil with light weight and little volume. Currently, the Pollution Control Department has 24 dispersants with varied characteristics on the list; and the department is responsible for making a decision which one would be appropriate for dispersing oil slicks case by case. This is because a dispersant is an industrial chemical that may present other impacts to aquatic organisms individually or

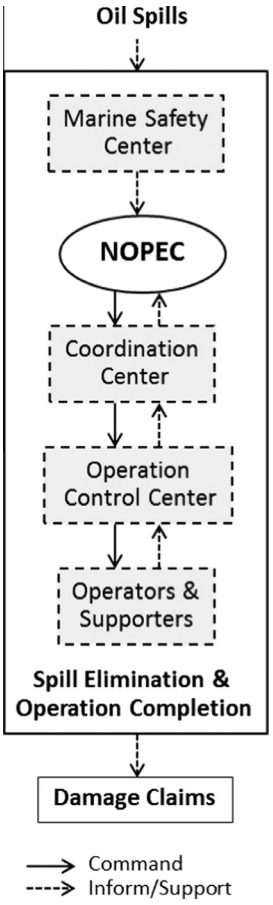

Fig. 1. Three major steps of the current oil spill contingency plan of Thailand, including oil spill elimination, operation completion, and damage claims.

when mixed with oil (e.g., Berninger et al., 2011; Floch et al., 2014). To efficiently disperse particles of the spilled oil, the approved dispersant should be applied within 24 h after the spills occurred in a water source. The effectiveness of dispersants also depends on the environmental conditions, e.g. spill location, wind speed, water currents, wave conditions, etc. (El-Raey et al., 1996; Pollution Control Department, 2001; ITOPE, 2011c).

Oil slick combustion may be another alternative. The effectiveness of in situ burning (the controlled combustion of spilled oil on water) mainly depends on (1) environmental conditions (e.g., weather and sea/wind state) at the spilled location and (2) type of the spilled oil and its ability to ignite and maintain burning under varied sea/wind conditions (Bowes 1996; Iwata et al., 2000; Aurell and Gullett, 2010; Fingas, 2011; ITOPE, 2014). This method needs to be implemented by an expert with caution because it may seriously affect an aquatic system and certain organisms in the in situ burning area and proximity.

Human beings may also be affected by oil spills in various dimensions, e.g., health, socioeconomic, and culture. These include, for instance, (1) physical injuries and acute and chronic health effects from exposure to oil and dispersants used in the cleanup, (2) mental health impacts or emotional stress from uncertainties about future livelihoods in oil spill areas, (3) economic losses due to the closure of contaminated fisheries, beaches, or tourism spots, (4) loss of trust in responsible parties and government agencies, (5) disruption of cultural traditions and subsistence ways of life; and (6) social conflict in communities from unequal treatments or assistances obtained from related governmental agencies, social welfare, etc. (Webler et al., 2010; Webler and Lord, 2010; Lord et al. 2012).