Chapter Five

CONCLUSION AND RECOMMENDATIONS FOR FUTURE WORK

Chapter 5 Conclusion and Recommendations for Future Work

5.1 Conclusion

Heavy vessel traffic including the oil tankers has induced great probability of oil spill to the Straits of Malacca. Studies have revealed that more than 300 oil spill incidents happened in the Straits for the period from 1976 – 2001. These would certainly affect the environmental quality and also the social-economic activities of the Straits. An oil spill prediction model is therefore a vital tool to mitigate the damages following an oil spill. The oil spill trajectory model, OILTRAJ developed for the Straits of Malacca, is reviewed in this study and the main objective is to enhance its capabilities for both short and long-term prediction. The techniques of oil spill trajectory model designed for the Straits of Malacca is presented and verification studies have been carried out to ensure its validity.

OILTRAJ model has employed generally the method suggested by Haug *et al* (1990). However, the oil drifting factors that have been considered for the narrow water channel of the Straits includes also tidal current and land-sea breezes. Thus the components are:

i. Wind induced current
ii. Background surface current
iii. Tidal current
iv. Land-sea breezes

Current induced by wind equaled to 3% of the wind speed has been adopted. The wind pattern in the Straits is greatly influenced by the tropical monsoons. A synoptic wind data could hence be made from the observed mean velocities of the wind, and this provides one of the main input for the OILTRAJ model. However, the measured / forecast data can always give more accurate simulation results. Surface current in the Straits of Malacca is generated as a result of the sea level difference at both the northwest and southeast entrances of the Straits. The current flows are relatively constant and a documented set of data generated from long-term observation has been used. Tidal current has been considered as one of the important surface drift of oil slick in the study area. Although the influence may be small for long-term assessment due to its oscillatory behavior, tidal effect is prominent during short-term prediction. Accurate tidal prediction is essential for oil slick booming and cleaning operation because the rapid assessment of the slick movement is required. Moreover, the tidal current is strong especially at the middle part of the Straits.

Because the Straits of Malacca is relatively narrow, the effects of the coastal wind have also been taken into consideration for oil spill trajectory calculation. Wind near to the coastal area (< 50 km for the shoal line) is generated from the one dimensional land-sea breeze model developed by Lim and Yeong (1992).

Motion vector contributed by each drifting component is calculated from different modules simultaneously. This design is for future expansion of the model. Investigation on the validity of each module can also be easily carried out. In the structuring of the algorithms, virtual resources of the computer are fully utilized for the maximum computation speed. A GIS software has also been incorporated to enable the interpretation of the simulation results.

To enhance the short-term prediction capability of OILTRAJ model for the Straits of Malacca, an accurate tidal model is essential. In this study, a one dimensional model has replaced the previous version of the two dimensional model for tidal prediction.

The use of the 1-D model is tested to be more reliable for calculation of the tidal currents in the field tests near to the coastal area when compared to the earlier attempts using 2-D model as reported in the work of Low *et al.*, (1994). Furthermore, the 1-D model is simpler to be constructed and only minimum resources are required. Comparison tests with data from the tide tables have confirmed the usefulness of the 1-D model. Four main tidal components of M_2 , S_2 , K_1 and O_1 have been considered and the generated results were matching well with the observed tidal elevations and currents from the tidal stations. This shows that the Straits of Malacca can be approximated as a channel with one dimensional tidal flow. Both diurnal and semidiurnal tidal components have been used because the Straits is influenced mainly by semidiurnal tidal current in the northern part and a mixed current of diurnal and semidiurnal especially at the southernmost portion of the Straits.

From the field tests that had been carried out for verification of the OILTRAJ model, it is concluded that all the drifting components of wind, surface current and tidal current contributed to the oil slick movement in short-term prediction of oil slick. Measured wind data was essential during the simulations, and the 6% wind factor had generated the most reasonable results for floating fruits. Tidal currents had played the main role during slow wind conditions. Good agreement of the results also indicated the correct prediction of the tidal current in both magnitudes and directions. However, to enhance the performance of the short-term prediction, more accurate surface current should be obtained.

In order to test the long-term prediction capability, OILTRAJ model is also used to simulate the event of a real oil spill. The results of Sun Vista oil spill incident that happened in the Straits of Malacca has also been used to verify the model. In this study, the effect of the tidal current was not significant as expected for long period drift. The main trajectory of the slick was primarily driven by the surface current owing to the calm condition, where winds were reported as light and variable throughout the simulation period. However, on-site measured wind is expected to provide a better prediction of the spillage.

5.2 Recommendations for Future Work

General good results shown in the verification tests have justified the methods applied and thus indicated the reliability of OILTRAJ model in oil slick trajectory calculation for the Straits of Malacca. Future development should focus on the following areas:

a) Enhance the accuracy of the OILTRAJ model by fine-tuning the grid size in the calculation domain. Higher resolution computation will minimize the effects of abrupt changes in vectors for the drifting components. This will however require the upgrading of the following components:

i) For oil spill far from the shoreline, offshore wind data should be used to calculate the spill trajectory. This is to avoid the onshore effects that may disturb the wind flow. The wind factor applied for the Straits of Malacca should also be investigated.

ii) More accurate surface current data is needed for both short-term and long-term simulations. A hydrodynamic model can also be used to generate the current information for oil slick trajectory calculation.

iii) Tidal model should be able to perform well at both offshore and near shore areas. Besides reducing the grid size, other effects for example fresh water flow from rivers mouth and influence of strong wind should also be studied.

The present two dimensional OILTRAJ model can also be upgraded to a more functional three dimensional model. This will be useful to determine at both the surface and subsurface portion, of the fate of spilled oils and other types of pollutant as well.

b) Extending the capability of the model to perform as an all-round oil spill management model. Functions for prediction of spilled oil weathering processes like those discussed in Chapter 2 should be tested for its reliabilities.

Spreading calculation is needed for determination of area coverage by oil slick. Other processes including the evaporation, natural dispersion and emulsification are also vital for oil fate determination. Many algorithms that have been developed in the past two decades for the oil fate calculation should be investigated. The most reliable methods should be obtained and be incorporated into the model of OILFATE. Oil characteristics properties during the spillage are important information for determination of the methods chosen for oil spill combat.

Full utilization of the GIS tools will enable the real time oil spill management to be mobilized through the computer terminals. This is possible due to the advances of internet technology. With the aid of the oil spill model, the spill directions and conditions can be predicted and cleaning operation can be carried out more effectively. Long-term oil spill contingency management can also be planned for training of oil spill response personnel.