THE ENGINEER STORY

e-ISSN: 3009 - 0792 Volume 1, 2023, 27-29

NUMERICAL SIMULATION OF OIL SPILL DRIFT

Lavine, W.*, Jamal, M.H. , Kasiman, E.H
Faculty of Civil Engineering, Universiti Teknologi Malaysia,
81310 UTM Johor Bahru, Johor, Malaysia.
* Corresponding author: wlavine2@graduate.utm.my

ABSTRACT

The Port of Tanjung Pelepas (PTP) located at the estuary of Pulai River, Johor is among the busiest ports in Southeast Asia and vulnerable to oil spill incidents. On 24th August 2016, an oil spill incident occurred at the Pulai River estuary and an interview was conducted with authority personnels to understand the extent of spillage. This study aims to develop the hydrodynamic of Pulai River and validate the oil spill incident. The hydrodynamic model was set-up. Measured tide and current data collected between 12th and 22nd October 2015 was used as model calibration. The prediction on movement of spill is crucial to assist port authorities to initiate effective counter measures to impede further spreading of oil within environmentally sensitive receptor area.

KEYWORD

Hydrodynamic, estuary, current velocity, hydrocarbon, Johor Strait

INTRODUCTION

One of the largest ports in Malaysia, Port of Tanjung Pelepas (PTP) situated in a sheltered bay at the Pulai River estuary is constantly exposed to oil spill risk. Coastal area of Tanjung Piai is affected by oil spill incidents, resulting in failure of mangroves to function as natural coastal defence system and increased erosion process of Tanjung Piai (Azlan and Othman, 2009; Awang et al., 2014). Natural mangrove habitats surrounding PTP that was designated as the Ramsar Site 1288 have poor coastal defence when exposed to spillage. Since PTP is surrounded by environmentally sensitive receptors area, it is crucial to protect the mangrove habitat. Therefore, the objectives of this study include developing a hydrodynamic model at Pulai River (PR) estuary and simulating the oil spill scenario to verify the oil transport model. Knowledge of oil movement is important to provide predictions of the movement of oil spill in the event of any marine oil spill emergency as trajectories are affected by currents and wind influence (Huang, 1983).

MATERIAL AND METHODOLOGY

The numerical model used to simulate the hydrodynamics of the coastal regime is Telemac2D. Telemac2D is an open-source software that solves the depth-averaged free surface flow equation as derived by Barre de Saint-Venant. Telemac2D solves the numerical code at each node of the computation domain through a finite-element method over non-structured grids consisting of triangles. The main results at each node of the computational mesh are the depth of water and depth-averaged velocity components (Goeury et al., 2015). Oil spill model introduced in Telemac 2D utilized the Eularian and Lagrangian approach (Goeury et al., 2014). Eularian approach observes fluid properties as a function of time and space, and in Lagrangian approach, the fluid particle is followed at each point (Patel et al., 2017). The combination of the Eularian and Lagrangian approach are used as the particle transport trajectory in oil spill modelling (Goeury et al., 2014). The hydrodynamic model is set up using BLUEKENUE as pre-processing software and TECPLOT was utilized as the post processor to view the simulated results.

RESULT AND DISCUSSION

The model boundary was set up in a way that the area of interest is located at the centre of the model domain. The model consists of two tidal boundaries with constant discharge from the river upstream as shown in Figure 1. Higher current during ebb than flood concludes that the estuary

has a good flushing system with water flowing out at higher speed from the estuary during ebb tide. A good flushing at the river mouth reduces sedimentation process that settles along the riverbed, as shown in Figure 2.

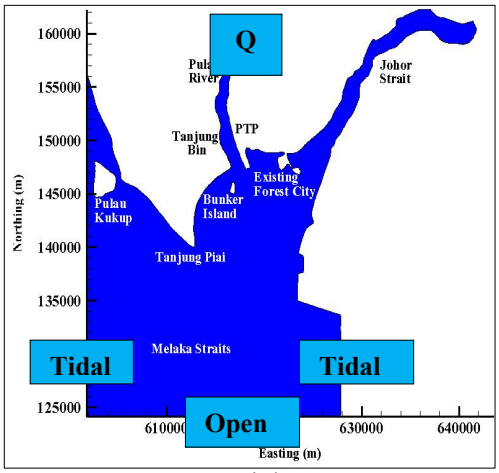

Figure 1: Model set-up

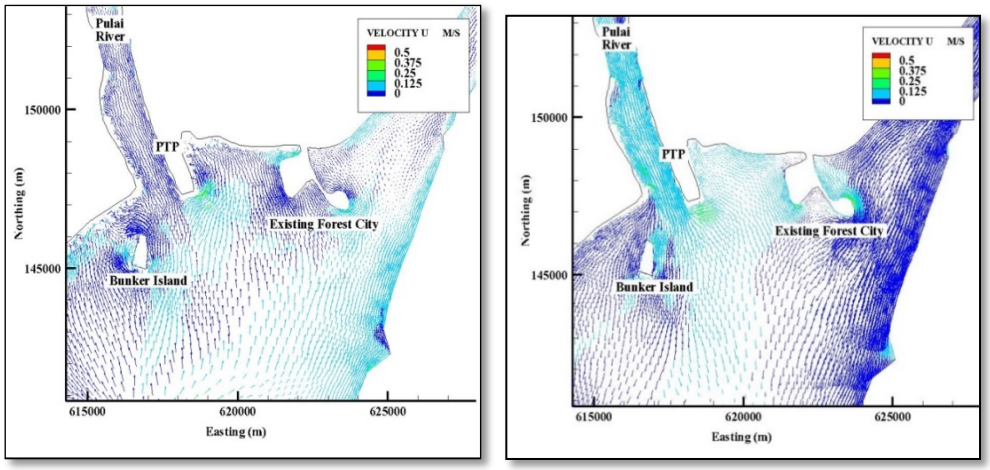

Figure 2: Computed surface flow during flood tide (top) and ebb tide (bottom) during neap tide

CONCLUSION

In conclusion, the TELEMAC-2D simulated the hydrodynamic condition around PTP coastal waters. Pulai River shows a good flushing system during neap tidal condition. Any oil spill occurrence along Pulai River is expected to be flush out of the river system.

ACKNOWLEDGEMENT

The authors would like to acknowledge the support of Research University Grant (reference number: 17H85) under Universiti Teknologi Malaysia and Fundamental Research Grant Scheme (reference number: 4F607) under the Ministry of Higher Education. The authors wish to thank Johor Port Authority and Port of Tanjung Pelepas Malaysia for the cooperation in environmental and secondary data collection.

REFERENCE

Awang, N. A., Jusoh, W. H. W. and Hamid, M. R. A. (2014). Coastal erosion at Tanjong Piai, Johor, Malaysia. Journal of Coastal Research, 71(sp1), 122-130.

Azlan, N. and Othman, R. (2009). Monitoring of mangrove areas using remote sensing toward shoreline protection. Proceedings of GIS Osrava, Malaysia.

Goeury, C., Hervouet, J.M., Baudin-Bizien, I. and Thouvenel, F. (2014). A Lagriangian/Eulerian oil spill model for continential waters. Journal of Hydraulic Research, 52(1), 36-48.

Huang, J. C. (1983, February). A review of the state-of-the-art of oil spill fate behavior models. In International Oil Spill Conference (Vol. 1983, No. 1, pp. 313-322). American Petroleum Institute.

Patel, R. G., Desjardins, O., Kong, B., Capecelatro, J. and Fox, R. O. (2017). Verification of Eulerian–Eulerian and Eulerian–Lagrangian simulations for turbulent fluid–particle flows. AIChE Journal, 63(12), 5396-5412.