This is an **extended abstract** from the paper

Chen, F.H, Yapa, P. D., and Nakata, K. (2004). "Simulating the Biological Effect of Oil Spills in Tokyo Bay by Using A Coupled Oil Spill - Toxicity Model," *Journal of Advanced Marine Science Technology, AMTEC*, Tokyo, Japan, 9(2), 131-155.

Simulating the Biological Effect of Oil Spills in Tokyo Bay by Using A Coupled Oil Spill - Toxicity Model

Fanghui Chen[1], Poojitha D. Yapa[1], and Kisaburo Nakata[2]
[1] *Department of Civil and Environmental Engineering*
Clarkson University, Potsdam, NY 13699, USA

[2]*Faculty of Marine Science and Technology*
Tokai University, 3-20-1 Orido, Shimizu, Sizuoka, 424-8610, JAPAN

Abstract

A three-dimensional oil fate/transport model combined with an oil toxicity model to simulate the biological effects due to an oil spill is described. Specifically, the focus of this paper is on the effect on fish. However, the model formulation can be extended to determine the effects on other species. The model can simulate oil releases from the water surface or from an underwater source. The output from the oil transport and fate model along with the oil toxicity data are used by the oil toxicity sub-model to determine the biological effect. The mortality of a fish kind is estimated by using the Additive Toxicity method.

From an economical point of view, Tokyo Bay is the most important bay in Japan. There are six ports in Tokyo Bay: Tokyo, Yokohama, Kawasaki, Yokosuka, Chiba, and Kisarazu. It is also a good fishing ground for pelagic fish and benthic shellfish. In this paper, seven scenarios are simulated which use real biological data in Tokyo Bay. These simulations investigate the difference in mortality of different species, as well as the mortalities for nighttime vs. daytime spills and a surface spill vs. an underwater spill. The simulations are the worst-case scenarios during a fishing season.

1. Introduction

Accidental oil spills in water bodies are a growing concern because of the possible impacts of petroleum hydrocarbons on marine organisms and ecosystems. This is in addition to other more straightforward effects such as toxicity from evaporated oils and the disruption of the usage of waterfronts. It is generally accepted that the impact assessment cannot be done through the data collection alone. The large amount of data needed for such an assessment is logistically impossible to collect. Therefore, computer models serve as an invaluable tool for an assessment of the environmental impact from an oil spill. These models can be categorized into sub-divisions as trajectory models, physical fates models, and models for environmental impact assessment that includes the biological impact.

.
.

.

In the absence of complete field data, computer models can fill the gap to assess the impact on aquatic biota due to oil spills. In this paper, a model is developed to simulate the exposure duration of marine species to concentrations of toxic substances and estimate the resulting mortality. The comprehensive three-dimensional oil spill model (Yapa and Zheng, 1998; and Yapa et al., 1999) forms part of the model. This model can simulate the effects due to oil spills that originate from the water surface or from deepwater as jets/plumes.

The scenario simulations in this paper show how the biological effect of an oil spill in Tokyo Bay is estimated based on the real data. These simulations show the worst-case impact during a fishing season. The percentage mortalities of different kinds fish are estimated by using the ATM method.

Some Results

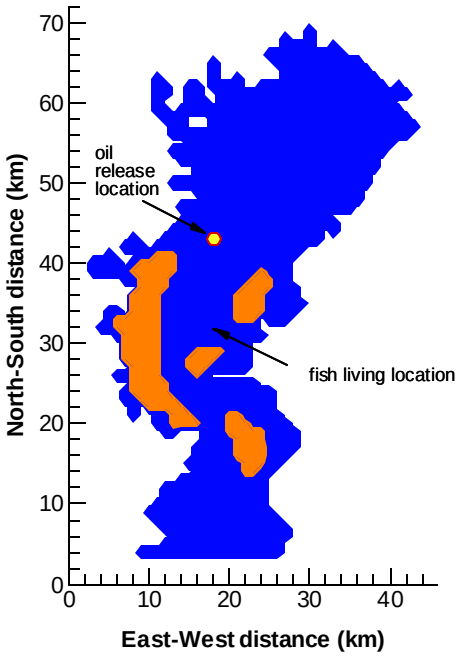

Fig. 19: Prawn habitat
(May – Dec. Water level: 10-30 m)

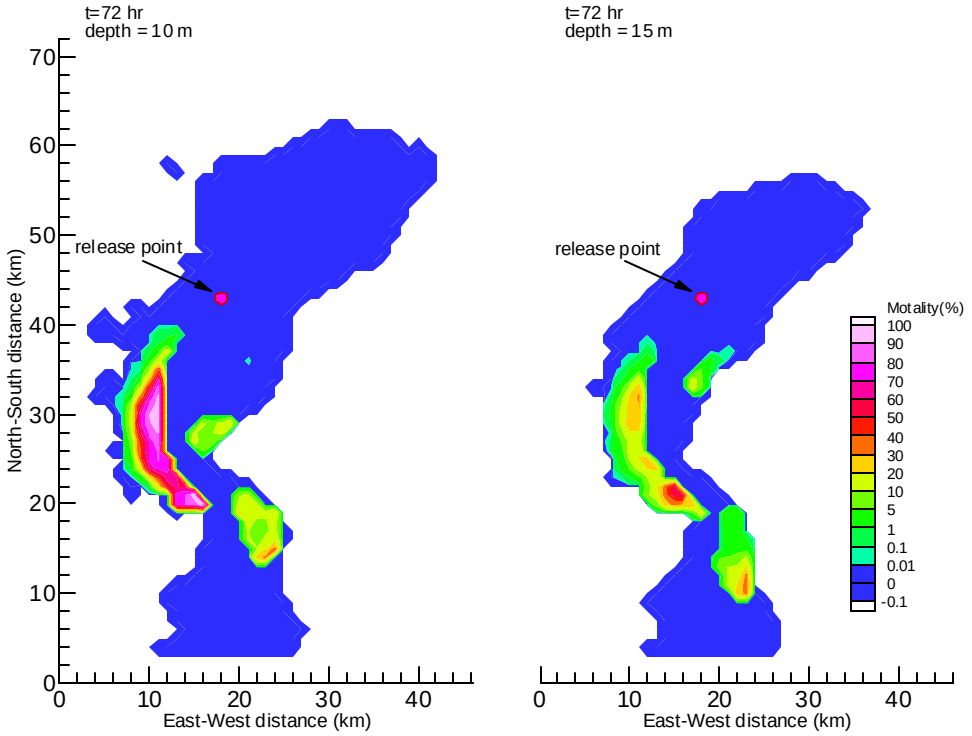

Fig. 20: Simulated mortality distribution for prawn (depth level 10 and 15 m)

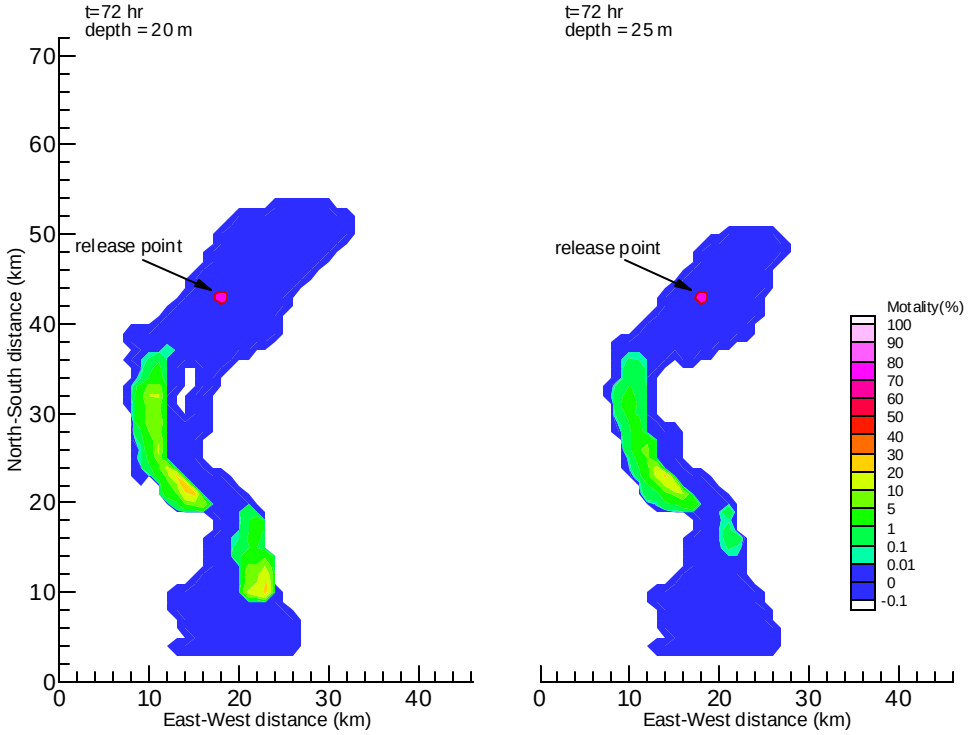

Fig. 21 Simulated mortality distribution for prawn (depth level 20 and 25 m)