PAJ Oil Spill Simulation Model for Japanese Waters
— Demonstration

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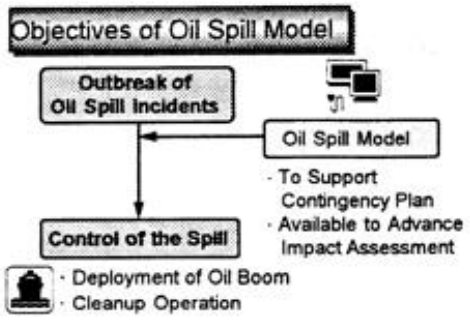
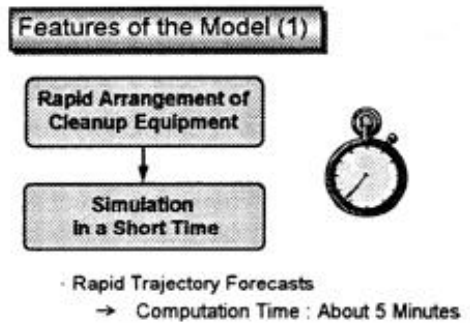


Outline of Oil Spill Model

As part of "Major Oil Spill Response Programme" Petroleum Association of Japan (PM) has developed a diffusion-drift model of spilt oil. The outline of this model was reported in PM Oil Spill Symposium '95. In this session, the oil spill model will be demonstrated more in detail.

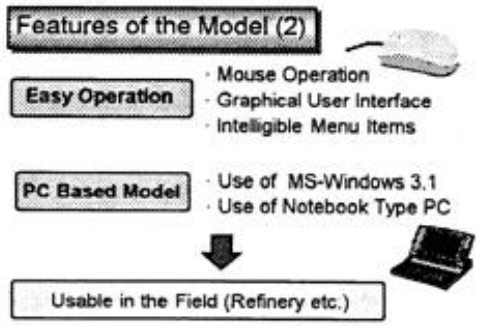
In an oil spill incident, the extent of damage on surrounding environment is largely depends on the initial response. The model, therefore, was developed to support the preparation of an emergency response program effective for clean-up operation.

The model is also useful in estimating in advance the impact of an oil spill according to the assumed incident.

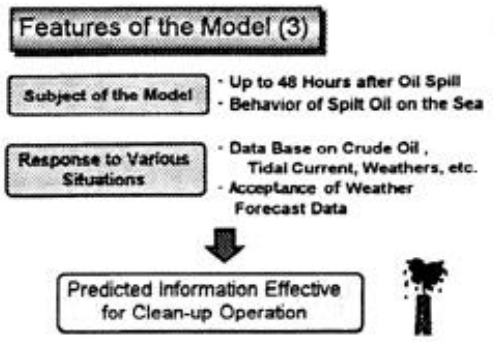


Features of the Model

Since the Objectives of the model is to provide information about the diffusion and trajectory of spilt oil after the outbreak of the incident, the predictive computation is designed to be completed in a short time. Practically, the trajectory of spilt oil can be predicted within about 5 mm; the computation requires about 15 min even for detailed prediction including the state of oil slick diffusion.

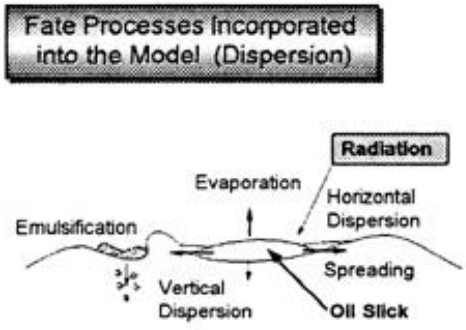


The model, in order to be used widely by people other than computer specialists, has materialized easy manipulation. Personal computers with MS-Windows3.1 installed including a notebook type are applicable to the model so that the model will be of service even in a clean-up operation field.



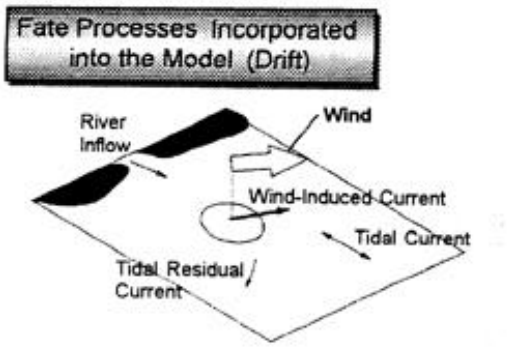
The model can predict the behavior of spilt oil on the sea in a period up to 48 hr after spillage. The model contains basic data including properties of crude oil and petroleum products, and tidal currents in the target area of sea, and predicts with enough accuracy to be effective for the clean-up operation.

We are now considering to provide more precise prediction with the model using newest weather forecast data.



Numerical Model

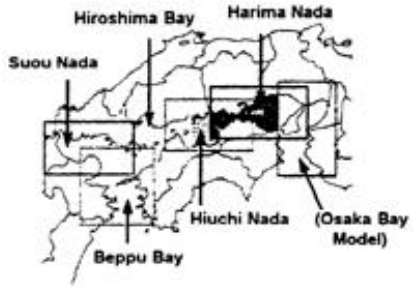
In the model, the behavior of spilt oil is divided roughly into two main phenomena of diffusion and drift in order to make up numerical models. In the diffusion phenomenon, such processes as spreading, evaporation, emulsification, horizontal dispersion, and vertical dispersion are taken up, and they are calculated on the basis of Fay, Mackay, et al.'s models.



As for drift phenomenon, processes such as tidal current, tidal residual current, river inflow, and wind-induced current are modeled. Data base of tidal current with a mesh unit of 1 km has been prepared in this model. Statistical data of marine wind are provided in the model, however, the utilization of weather forecast data is preferable to improve the accuracy of prediction in an oil spill.

Enclosed Sea Areas of the Model

Sub-Areas of Seto Inland Sea Model



Example Simulation at Tokyo Bay

Calculation Conditions

- Time of Spillage : 12:00, March 5, 1996
- Spilt Oil : Arabian Light Crude 5,000KL (Spill : Continuously 5 Hours)
- Leak Point : In the Middle of Tokyo Bay
- Weather : Average for March
- Calc. Period : Up to 48 Hours after Spillage

Objectives Sea Area of the Model (Enclosed Area of Sea)

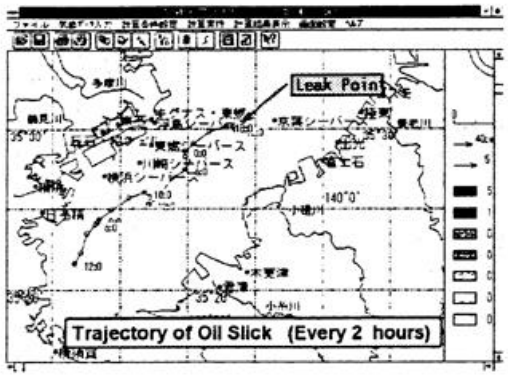
The areas of sea, to which the model is applicable, are coastal areas of sea, on which coast oil refineries etc. are located. The eight enclosed areas of sea have been modeled so far, including Tokyo Bay, Ise Bay, Osaka Bay, and Seto Inland Sea. Seto Inland Sea, having much larger area than others, is divided into five areas of sea of Harima-nada, Hiuchi-nada Hiroshima Bay, Suou-nada, and Beppu Bay. Each of the models of these areas of sea can be used independently, and the prediction for a district covering more than one area is also possible.

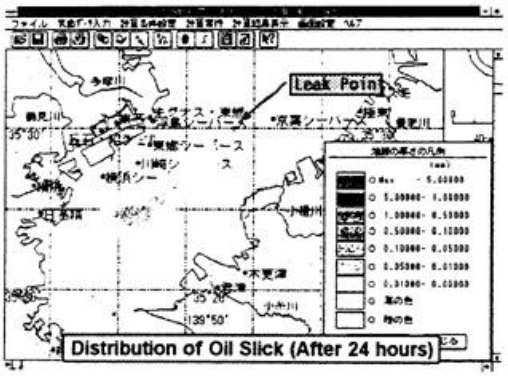
Example of Simulation (Tokyo bay model)

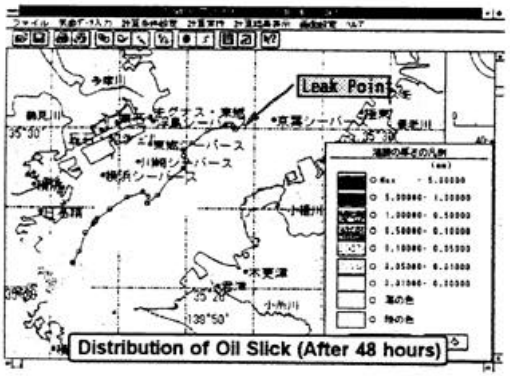
A typical example of simulation, which was carried out using the model, is shown in the first place. A large-scale oil spill incident is imagined to set up the calculation conditions. Assuming that 5,000KL of Arabian Light Crude was spilt during 5hr (1,000KL/hr) and that the spillage broke out at 12:00, March 5, 1996, the behavior of spilt oil was predicted in a period up to 48 hr after spillage.

The weather conditions (direction and speed of wind) necessary for the simulation are provided by taking the average values of every hour in March in Tokyo Bay area of sea.

Example of Results of Simulation







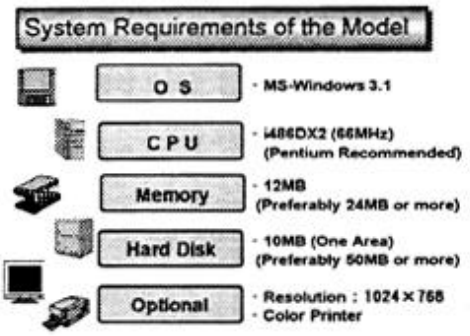
Since practical operations are shown in the later demonstration, the typical results of simulation are shown in this section.

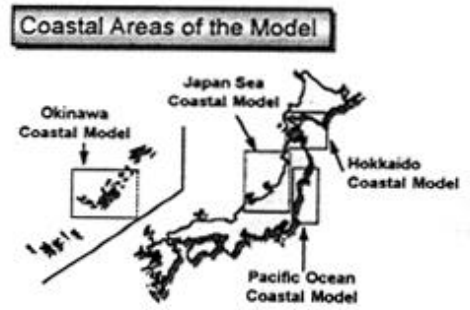
First, the user interface image of the model and the results of trajectory of an oil slick are indicated. The trajectory of the center of the oil slick every 2 hr after the outbreak of the incident.

Next, the distribution of the oil slick is given in a diagram. For easy understanding, the results are displayed continuously.

The oil slick is thick and spread only in a narrow range in the initial stage of spillage, but the slick becomes thin and diffuses into a wider area with the passage of time. The oil slick is predicted to drift down the south-west dominantly by the effect of the wind.

In this model, a phenomenon is modeled in which the oil slick drifts leaving a tail behind it on the trajectory and can be confirmed as the results of simulation on the display. In an actual incident, a clean-up operations including oil boom Deployment are set up to prevent the oil slick from diffusing into such a wide area as predicted by the model.





Demonstration

The required specifications of a personal computer to which the oil spill model is applicable are as follows. In this demonstration, a notebook-type personal computer with i486DX4(75MHz) CPU was used.

The typical functions of the model and its usage are demonstrated to show the practical use of the model. A series of prediction procedures is indicated by such operations as:

- Setting up calculation conditions
- Execution of simulation
- Display of the results

Future Topics

The following three points are indicated as the topics of the model in future:

First, the prediction accuracy for drift is to be improved. The improvement will be attained chiefly by the verification on the basis of drift experiments which have been carried out since last year.

Next, the operability is to be improved so that the results can be displayed in sequence according to the progress of calculations. The conversion to OS such as Windows95 which is estimated to be widely used in near future is another topic.

Last, the subject of the model is to be extended from enclosed areas of sea to oceanic coastal area of sea as given in a figure.