FISHBYTE SECTION

Fishbyte is the Newsletter of the Network of the Tropical Fisheries Scientists

Editorial

This issue of Fishbyte includes five contributions. The paper by Gayanilo et al. is the third of a four-part series on B:RUN, a low-level geographic information system software to assist fisheries and coastal zone management in Brunei Darussalam. The contributions of D. Okeyo and J. Maithya provide updates on the ichthyofauna of selected waterbodies in Kenya. We especially note that the paper by J. Maithya contributes to the ongoing discussion on the ecological role of the Nile tilapia introduced to Lake Victoria. W. Mhlanga presents some population parameters for *Oreochromis mortimeri* in Lake Kariba (Zimbabwe), while S. Ragonese and M. Bianchini give results of length-based assessments conducted on *Trisopterus minutus* in the Strait of Sicily. The issue ends with the usual announcements for NTFS members.

Read on and do keep the contributions coming!

G. Silvestre and V. Christensen

A Low-level Geographic Information System for Coastal Zone Management, with Applications to Brunei Darussalam: Part III: Simulation and Tracking of Oil Spills*

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Abstract

B:RUN is a low-level GIS software designed to help formulate options for the management of the coastal zone of Brunei Darussalam. This contribution presents the oil spill simulation module of B:RUN. This simple module, based largely on wind and sea surface current vector parameters, may be helpful in formulating relevant oil spill contingency plans. It can be easily adapted to other areas, as can the B:RUN software itself.

Introduction

No rules, however elaborate, or human skill can completely prevent a complex industrial system from experiencing accidents. The vast offshore oil resources and the continuing development of the oil industry of Brunei Darussalam (Silvestre et al. 1992) thus implies a potential risk of oil spills occuring, with catastrophic effects on the living coastal resources of the country. Oil spill contingency plans can help define measures to mitigate the effects of such spills. Such plans require, among other things, the simulation of the potential trajectory, speed and spread of oil slicks. The oil spill simulation module of the B:RUN software (Gayanilo et al. 1997; Pauly et al. 1997) which is presented here, is based on the SPOILS-1 software of De las Alas and Bentillo (1992), itself representing local adaptation of the STOLOM III (SIPM 1986) software package.

Data Requirements

The vector parameters required by the simulation module are

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summarized in Table 1. The parameters which characterize the spread of oil on sea water surfaces are user-defined and are provided with default values (Table 2). Users may alter these defaults as the need arises (see Fay 1971 for a detailed explanation of the user-defined parameters).

Table 1. Description of B:RUN files to simulate oil spills.

Filename	Remarks
CURRENT1.DAT	Vector file to describe the water current for the months of January to March
CURRENT2.DAT	Vector file to describe sea surface currents for the month of April
CURRENT3.DAT	Vector file to describe sea surface current for the months of May to November
CURRENT4.DAT	Vector file to describe sea surface currents for the month of December
WIND1.DAT	Vector file to describe wind direction and speed for the months of January to March
WIND2.DAT	Vector file to describe the wind speed and direction for the month of April
WIND34.DAT	Vector file to describe the wind speed and direction for the months of May to December
XYMAP.DAT	File containing the coordinates of the graphic screen

Other user-defined inputs are: (i) the choice of a period of the year (January to March, April, May to November and December), each characterized by a certain wind and tidal regime; (ii) the origin of the spill, i.e., any of the nine oil rigs close to the coast of Brunei Darussalam; and (iii) the wind strength, expressed through the Beaufort scale.

The vector files supplied with the B:RUN disk may be altered using any text editor. The following describes the data files in Table 1:

1. The first line is the header line describing the file, and is not used by B:RUN;
2. Subsequent line entries describe a current or wind vector of a sector. There are 6 sectors on the horizontal scale (from 113°45' to 115°15') and 5 on the vertical scale (from 4°30' to 5°45'), i.e., each sector is dimensioned into squares of 15 by 15 minutes;
3. The sectors are labeled using the format xy where x is the column number and y the row number. Sector '11' is the sector on the lower left corner and label numbers are increasing to the right and going up;
4. Entries to the file are sorted such that the first 3 line entries refer to sector '11', the second to sector '12', the third sector '13' and so on until it reaches sector '65';
5. For each group of three entries, the first line entry refers to strength or speed, the second line is the label of the sector and the third, the direction in degrees (from 0° to 360°).

Table 2. Characteristics of spilled oil and sea water. Shown here are default values and their unit of measurement incorporated in B:RUN.

Parameter	Default value	Unit
Oil Characteristics		
Oil spill volume	10 000.00	m^3
Mass density	867.00	kg/m^3
Surface tension	0.0057	$Newton/m^2$
Gasoline content	30.00	%
Kerosene content	10.00	%
Heavy distillates content	25.00	%
Light distillates content	15.00	%
Residual content	20.00	%
Sea water characteristics		
Mass density	1 025.00	kg/m^3
Kinetic viscosity	0.0000012	m^2/sec

Trajectory, Speed and Spread of Oil Spills

The trajectory and the speed of the oil slick can be estimated using the resultant of the water current vector and the wind vector for a given area and time (see also De las Alas and Bentillo 1992),

$$\vec{V} = \vec{W} + \vec{C} \quad \text{...1)}$$

The integral of Equation 1 will provide the location of the mass at time t,

$$\vec{P}_t = \vec{P}_o + (\vec{W} + \vec{C})\Delta t \quad \text{...2)}$$

where $\vec{P}_t$ is the vector position of the oil slick at time t which originated at vector position $\vec{P}_o$.

The spread or the slick radius is computed by considering three stages of dispersion: (1) a gravity-inertia regime; (2) a gravity-viscous regime; and (3) a final, surface tension regime (Fay 1971; De las Alas and Bentillo 1992 for details on the mathematical models employed). Note that these models are deterministic, i.e., they do not incorporate stochastic components. The trajectories obtained by B:RUN will differ slightly from those in De las Alas and Bentillo (1992), who did not specify the oil characteristics they used in their simulation.

The simulation stops when a spill reaches the coast (Fig. 1), or when it exits the sea area defined by the computer's display screen.

Conclusion

Several simulated runs of different magnitudes and from varying locations are required to establish effective contingency plans, particularly with reference to changing seasonal regimes. The oil spill module of B:RUN allows evaluation of differing oil spill scenarios in Brunei Darussalam as a function of seasonal wind and current regimes. The results are useful in the process of formulating an oil spill contingency plan for the country.

The approach presented may also be used to simulate a spill of other dangerous chemicals, or to simulate the transport of marine debris driven by wind and sea surface currents. Moreover, the module may be easily adapted to other areas or coastlines, similar to the rest of the B:RUN software.

References

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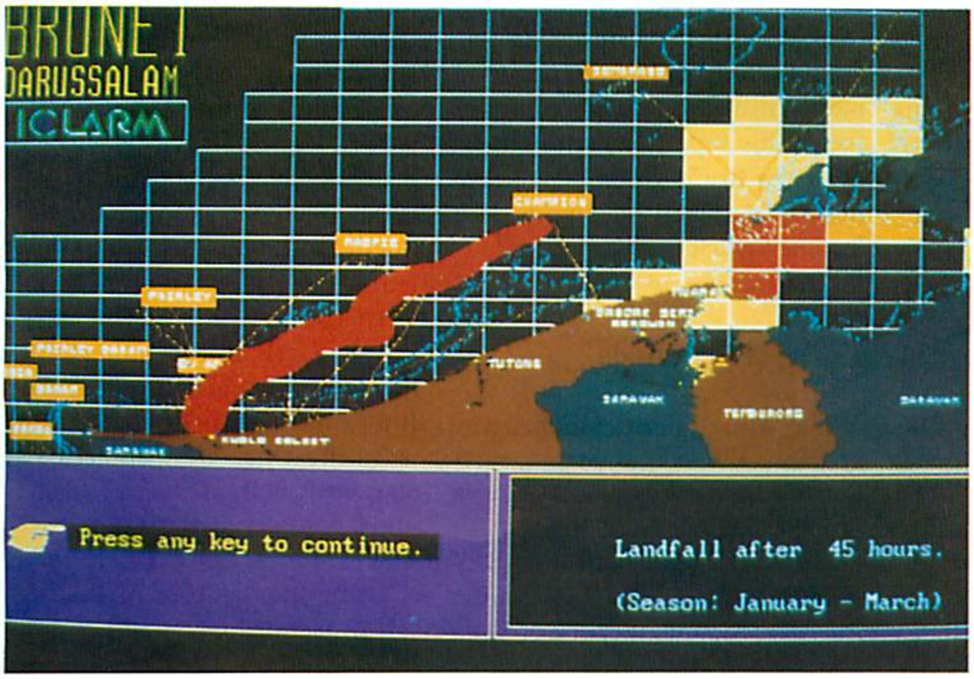

Fig. 1. Location of nine oil rigs off Brunei Darussalam, the sources of potential oil spills. Here, an oil spill is simulated which originated in the Champion field and which hit the coastline of Brunei Darussalam after about 2 days of being pushed southwestwards by the monsoon winds and water current prevailing from July to March. The figure also shows the occurrence of red tides in the northeastern part of Brunei Darussalam, another feature of B:RUN (Pauly et al. 1997). Other coastal features (e.g., oil pipelines, reefs/hard bottom areas) are also illustrated.