Southeast Asian Fisheries Development Center

Petroleum Hydrocarbon Contamination in Seawater along the Western Coast of the Philippines

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ABSTRACT

A study on petroleum hydrocarbon concentrations in seawater from the South China Sea off the western coast of the Philippines was conducted during April to May 1998. The concentrations of dissolved/dispersed petroleum hydrocarbons (DDPH) in seawater samples were measured at 31 stations, using Ultraviolet Fluorescence (UVF) Spectroscopy technique. The DDPH concentrations were found to be in the range of 0.02 – 1.47 µg/l as chrysene equivalent, with an average of 0.25 µg/l.

An attempt was made to compare between petroleum hydrocarbons in seawater samples from the near-shore area (8 stations) and the offshore area (23 stations). It was found that the DDPH concentrations of the near-shore stations were in the range of 0.03 – 0.47 µg/l, with an average of 0.12 µg/l, whereas the DDPH concentrations of the offshore stations were in the range of 0.02- 1.47 µg/l, with an average of 0.29 µg/l. However, the student's t-test of the two data groups indicated that the two means were not significantly different at $\alpha = 0.05$.

Introduction

The waters of Southeast Asia occupy a crossroad position between the Indian and Pacific oceans on the trade routes of Europe, Africa, the Middle East, Japan and other Far Eastern nations. The major transportation route for oil imported into the region is from the Middle East and Africa through the Straits of Malacca and the South China Sea, most of it in transit to Japan, with offshoots to Thailand, Taiwan and the Philippines. Hence, the water along this route is constantly at a risk of being contaminated by oil, either from accidental spills or routine ship operations such as loading, discharging and bunkering.

The various sources from land and marine-based oil pollution of the ASEAN marine environment have been studied (WHO/PEPAS, 1981). Hydrocarbon concentrations were measured in both the open seas and coastal waters. Concentrations vary widely in the region, but coastal areas are generally more than 1000 times higher than the open sea baseline measurement (Bilal and Kuhnhold,1980).

This study deals mainly with part of the South China Sea off the western coast of the Philippines to provide an information on the levels of petroleum hydrocarbons generally present in this region. The study is a joint cooperation between the Bureau of Fisheries and Aquatic Resources (BFAR) of the Philippines, the Marine Fishery Resources Development and Management Department (MFRDMD) of Malaysia, Southeast Asian Fisheries Development Center, Training Department (SEAFDEC TD) and Chulalongkorn University, Thailand.

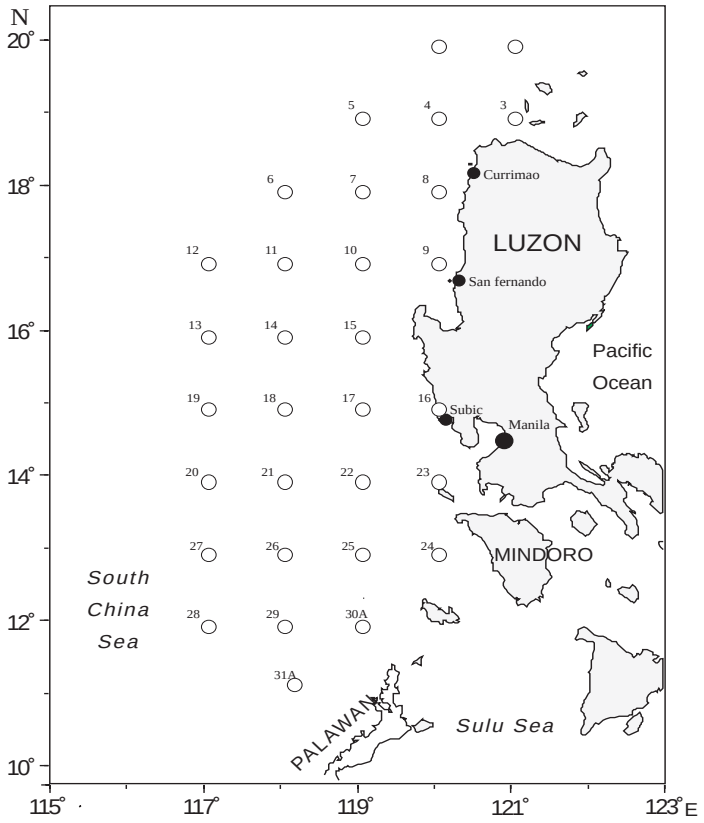

Fig. 1. Map of the sampling stations off the western coast of the Philippines.

Materials and methods

Sampling sites

Water samples were taken from 31 stations along the western coast of the Philippines. Sample collection took place on board the M.V.SEAFDEC between the months of April to May 1998. The study area is located between 117° and 121° E longitude and 11° and 20° N latitude. These included 8 stations from the near-shore area and 23 stations from offshore area (Figure 1).

Analytical procedures

Seawater samples were collected at 1 meter depth below sea surface, using 4 -liters amber coloured glass bottles mounted on a weighted frame, the design of which is in accordance with IOC standard procedure (IOC/UNESCO,1984). There after 100 ml of each sample was discarded and immediately replaced with 50ml nano-grade hexane. The samples were thoroughly shaken before storage in a dark, cool place. Analysis for dissolved/dispersed petroleum hydrocarbon (DDPH) concentration was conducted in the laboratory upon returning to shore.

Each water sample was extracted three times with nano-grade hexane in a separatory funnel. The combined hexane volume was dried by an addition of anhydrous Na_2SO_4 and concentrated to 5 ml using a rotary evaporator. Ultraviolet fluorescence (UVF) intensity of the reduced samples was measured at an emission wavelength of 360 nm and excitation wavelength of 310 nm, using a Perkin Elmer Model 3000 Spectrofluorometer.

The measurement of UVF intensity obtained from the samples was calibrated against standard chrysene. Statistical analysis for this study was a simple student's t-test.

Table 1 Dissolved/dispersed petroleum hydrocarbon (DDPH) concentrations in seawater from sampling stations in the South China Sea (μg/l as chrysene equivalents).

Station	DDPH	Station	DDPH
1	0.38	17	0.03
2	0.45	18	0.03
3	0.03	19	0.02
4	0.04	20	0.02
5	0.13	21	0.05
6	0.35	22	0.51
7	0.05	23	0.04
8	0.03	24	0.03
9	0.04	25	0.32
10	0.86	26	0.64
11	0.02	27	0.2
12	0.02	28	0.32
13	0.03	29	0.27
14	0.02	30	0.56
15	0.47	31	1.47
16	0.26	Average	0.25

Table 2 Dissolved/dispersed petroleum hydrocarbon (DDPH) concentrations categorized according to geographical location into near-shore and offshore areas (μg/l as chrysene equivalent).

Near-shore		**Offshore**			
Station	**DDPH**	**Station**	**DDPH**	**Station**	**DDPH**
3	0.03	1	0.38	18	0.03
4	0.04	2	0.45	19	0.02
8	0.03	5	0.13	20	0.02
9	0.04	6	0.35	21	0.05
15	0.47	7	0.05	22	0.51
16	0.26	10	0.86	25	0.32
23	0.04	11	0.02	26	0.64
24	0.03	12	0.02	27	0.2
Average	**0.12**	13	0.03	28	0.32
		14	0.02	29	0.27
		17	0.03	30	0.56
		Average	**0.29**	31	1.47

Table 3 Summary of statistical values (mean, range, S.D., variance, t-value) of DDPH concentrations in the South China Sea (μg/l as chrysene equivalents).

Area	**n**	**Range**	**Mean**	**S.D.**	**Variance**
Near-shore	8	0.03 - 0.47	0.11	0.16	0.03
Offshore	23	0.02 – 1.47	0.29	0.35	0.12

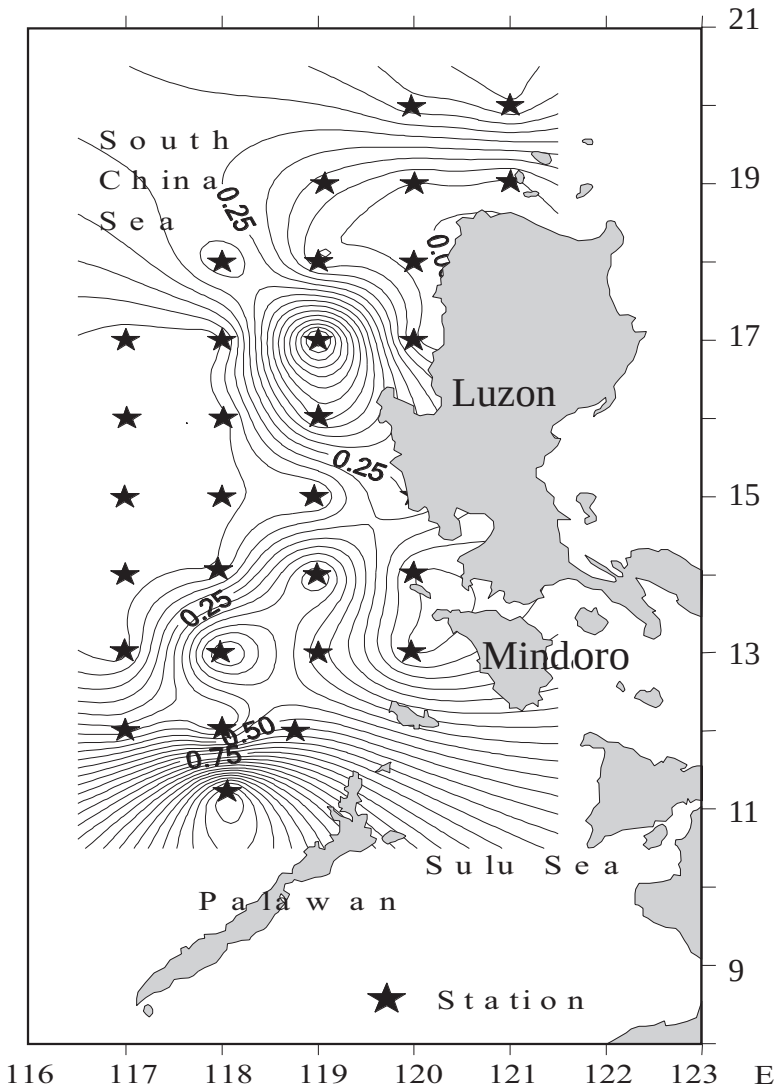

Fig. 2. Contour lines of DDHP concentration in the South China Sea.

Results and discussion

Analysis of the seawater samples taken from 31 stations in the South China Sea yields the total of DDPH concentration values as shown in Figure 2 and Table 1. The obtained DDPH concentrations are within the range of 0.02-1.47 µg/l as chrysene equivalent, with a mean value of 0.25 µg/l.

DDPH concentrations in seawater can be grouped into two general areas, namely the near-shore and the offshore stations (Table 2). The DDPH concentrations of the near-shore stations were in the range between 0.03-0.47 µg/l, with the mean value of 0.11 µg/l. Meanwhile, the offshore concentrations were found in the range of 0.02-1.47 µg/l, with an average value of 0.29 µg/l. However, student's t-test of the data indicated no significant difference between the mean of the near-shore area as compared to that of the offshore area, within the 95% confidence interval (Table 3).

Figure 2 shows elevated concentrations of DDPH in water samples off the Palawan Island, particularly at Station 31 which has the highest DDPH concentration of 1.47 µg/l as chrysene equivalent. This high concentration may be due to the fact that Station 31 is located near an

offshore oil exploration and production site. However, the high DDPH concentrations at Station 10, 15, 22, 25, and 26 would be probably due to contamination from shipping operation since these stations are located along a major shipping route for crude oil transport in Southeast Asia (Finn et al., 1979).

Generally the concentrations of DDPH in this part of the South China Sea are lower than that in the Gulf of Thailand and the east coast of Peninsular Malaysia (Wattayakorn et al., 1998; Wongnapapan et al., 1997). This finding indicates that coastal areas and semi-enclosed marine embayment, like the Gulf of Thailand, have higher levels of petroleum contamination in water as compared to the open sea areas since the biggest contributions of oil come from terrestrial sources (National Research Council, 1985) .

Conclusions

1. The analysis shows that contamination of DDPH in this area is likely to be the result of maritime and shipping activities as well as offshore oil exploration and production.
2. The mean value of DDPH concentrations from near-shore and offshore areas is not significantly different from each other within the range of the 95% confidence interval.

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