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Sewage Pollution in Kelang River and its Estuary

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RINGKASAN

Ketinggian 'faecal coliforms' yang telah dikesan di dalam Sungai Kelang menunjukkan airnya telah tercemar oleh najis manusia. Di dalam kiraan purata di sungai ini, 'faecal coliforms' di Stesen I, II, III, IV, V dan VI adalah seperti berikut, 113/100 ml, 1 x 10^6/100 ml, 1 x 10^5/100 ml, 1.6 x 10^6/100 ml, 5.8 x 10^3/100 ml dan 260/100 ml. Pengiraan coliforms dalam semua stesen, kecuali Stesen I, adalah terlalu tinggi dari yang disarankan oleh WHO iaitu pada had 100 'faecal coliforms' dalam 100 ml sebagai had panduan untuk air mandi. Purata kepekatan 'faecal coliforms' dalam endapan di Stesen I, II, III dan IV adalah seperti berikut, 17.9/g, 1 x 10^4/g, 3.2 x 10^4/g dan 1.6 x 10^4/g. Binaan 'faecal coliforms' di muara Sungai Kelang adalah lebih rendah dari perairan di Pulau Pinang dan Johore. Sebab-sebabnya tidaklah begitu jelas. Besar kemungkinannya bahawa terampai zarah di dalam air boleh menyebabkan penghilangan 'faecal coliforms' di dalam kuala sungai itu.

SUMMARY

High faecal coliform counts detected in Kelang River reveal that the River is being heavily polluted by domestic sewage discharge. The average faecal coliform counts in water from Stations I, II, III, IV, V and VI were 113/100 ml, 1 x 10^6/100 ml, 1 x 10^5/100 ml, 1.6 x 10^6/100 ml, 5.8 x 10^3/100 ml and 260/100 ml respectively. As compared to the WHO recommended guide limit of 100 faecal coliforms/100 ml for bathing water, counts in all stations except Station I were much higher than the recommended limit. The average concentration of faecal coliforms in sediment of Stations I, II, III and IV were 17.9/g, 1 x 10^4/g, 3.2 x 10^4/g and 1.6 x 10^4/g respectively. The faecal coliform counts at the estuary of Kelang River were much lower than those of the coastal waters of Penang and Johore. The reason is not clear. Most probably the suspended solids play an important role in the disappearance of faecal coliforms in the estuary.

INTRODUCTION

It has frequently been reported that the domestic sewage disposal system in Malaysia is inadequate and polluted rivers have sometimes caused outbreaks of water borne diseases (Consumer's Association of Penang, 1978). Recent reports indicate high faecal coliform counts in the coastal water of Penang and Johore (Maheswaran, 1978). These is hence sufficient indication that our coastal water is being polluted with sewage discharge.

Kelang River which courses through Kuala Lumpur, is suspected to be heavily polluted by domestic sewage discharge. However, no studies of sewage pollution in this river have ever been conducted. This study was therefore undertaken to investigate the distribution of faecal coliforms in the water as well as in the sediment of this river and its estuary.

MATERIALS AND METHODS

Six stations were chosen for this study (Figure 1): Station I (Kemansah River), Station II (Gombak River), Station III (Kelang River at the heart of Kuala Lumpur), Station IV (0.5 Km upstream of Puchong Weir) were the same stations described in another paper (Law and Mohsin, 1980) Station V was located at about 4 Km from Port Kelang and Station VI was located at South Port, Port Kelang.

The distance between Station I and Station VI is about 100 Km. As it is difficult to sample all the stations within the same day, only three to four

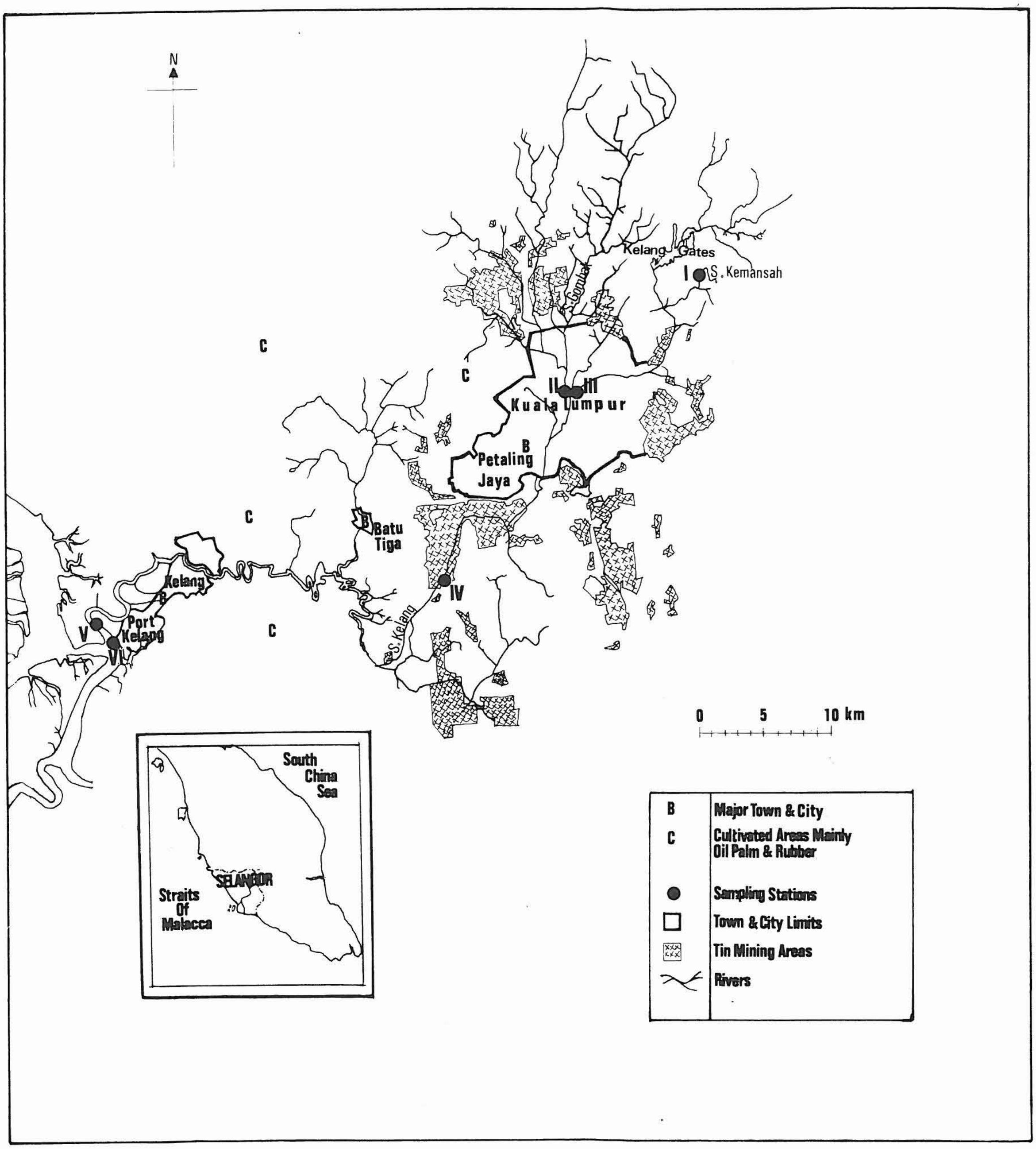

Fig. 1: Sampling stations along Kelang River and its estuary

stations were sampled on every field trip. Stations I, II, III and IV were sampled between January and March 1979, while Stations IV, V and VI were sampled between April and May 1979. Station IV was sampled throughout the study period because this station was located about 4 Km from the maximum tidal influence. The faecal coliform counts in this station would indicate the level of sewage discharge from the Kuala Lumpur area which will flow through Shah Alam, Kelang and then to the estuary. No sediment from Stations V and VI was tested because of lack of sampling facilities.

Water samples for faecal coliform counts were taken at a depth of two feet with a sterile 250 ml glass bottle. A total of one liter of water sample was collected and pooled for analysis. Sediment for faecal coliform count was sampled at a depth of 5 cm with a modified Chandelier sampler (Grunnet and Gunstrup, 1976). About 10g of sediment was used per sample. Water for pH, dissolved oxygen content, biological oxygen demand and salinity analysis was taken with a Lamotte horizontal sampler at the same depth.

The faecal coliform concentration was used as an index of domestic sewage pollution. Faecal coliform counts were estimated by the multiple-tube fermentation technique after WHO, (1977a). The criteria for positive identification of faecal coliforms are as follow: (a) generation of both acid and gas after 48 hours at 36°C; (b) generation of both acid and gas after 24 hours at 44°C and (c) positive indole reaction after 24 hours at 44°C. Dilution and inoculation were done at the field immediately after the sample was collected. Five dilutions of each sample were tested.

pH was measured with a portable Albert pH meter. Dissolved oxygen, biological oxygen demand, and total suspended solid determinations were carried out by techniques of Standard Methods (1975). Salinity was determined by silver nitrate titration (Strickland and Parsons, 1968). Specific conductance was determined with a Kent M.C. 3 conductivity meter.

RESULTS AND DISCUSSION

The results of faecal coliform counts and water quality determinations in the Kelang River and its estuary are shown in Tables 1 and 2 respectively. Faecal coliform counts in the water increased rapidly from Stations I to III and IV as indicated by the increasing average values of 113/100 ml, 1×10^5/100 ml and 1.6×10^6/100 ml for Stations I, III and IV respectively. After Station IV, counts were observed to decrease with values for Station V and VI averaging at 5.8×10^3/100 ml and 2.6×10^2/100 ml respectively. High average counts of 1×10^6/100 ml at Station II indicate that sewage discharge from the Gombak area contributed a significant faecal coliform loading to Kelang River through the Gombak River.

As compared to the recommended guide limit of 100 faecal coliforms/100 ml for bathing water (WHO, 1977b), the faecal coliform counts in the water of all stations along Kelang River and its estuary, except Station I, exceeded this recommended guide limit. Station I was within this limit, while the levels at station II, III, IV, V and VI were 10,000, 1,000, 16,000, 58 and 2.6 times correspondingly higher than the recommended limit. These data reveal that the middle reaches of Kelang River (around Kuala Lumpur) is being heavily polluted by domestic sewage discharge.

A significantly higher faecal coliform counts was detected in Station IV as compared to Station III. This was probably due to the input of sewage discharge from Gombak area as well as the input of sewage effluent along Kelang River between Stations III and IV.

The faecal coliform counts in the water at Station IV were comparatively lower on 12th January and 15th March; the counts being 7.9×10^4 and 2.0×10^4/100 ml respectively, while during other sampling days the counts were in the range of 1×10^6/100 ml. The rainfall data around the area of Station IV were analysed and correlated with the coliform counts. Daily rainfall data at the meteorological station of Petaling Jaya were provided by Kajicuaca Malaysia for this study. On 12th January and 15th March 1979 there was 0 mm rainfall while on 15th February, 12th April and 3rd May 1979 rainfalls of 8.8 mm, 79.8 mm and 0.6 mm were recorded respectively. These data indicate that on dry days there were fewer faecal coliforms in the water as compared to rainy days. This was probably due to the effect of suspended solids which were brought into Kelang River from Gombak River as well as from the mining activities around Kuala Lumpur. During dry days, the reduced flow rate in the river led to large amounts of suspended solids being deposited on the bottom of the river. The disappearance of faecal coliforms may be due to the adsorption of the coliforms on to the suspended solids which sank to the bottom of the river. On rainy days, the bottom sediment, rich in faecal coliforms, may be resuspended in the water thus giving rise to a high count of faecal coliforms.

The dilution and inactivation effects of sea water on faecal coliforms (Hansen, 1976) may explain the observations of significantly higher levels of faecal coliforms at low tide as compared to those at high tide and receding tide at Station V. These effects may also explain the observation of the three- to four-fold reduction in faecal coliforms at the estuary as compared to counts at Station IV.

TABLE 1

Faecal coliform counts in Kelang River and its estuary. Sampling times are in parenthesis. Blanks denote tests not performed.

Station	I		II		III		IV		V		VI		
Date	Water[1]	Sediment[2]	Water	Sediment	Water	Sediment	Water	Sediment	Water	Sediment	Water	Sediment	Tidal Condition
12.1.79	20 (1500)	1.6	3.1×10^4 (1700)	1.67×10^3	2×10^5 (1615)	1.45×10^2	7.9×10^4 (1145)	1.96×10^3	—	—	—	—	
15.2.79	1.6×10^2 (1310)	11	1.3×10^6 (1600)	1.3×10^3	7.9×10^5 (1500)	6.3×10^3	1.7×10^6 (1015)	1.2×10^4	—	—	—	—	
15.3.79	1.6×10^2 (1245)	41	1.6×10^6 (1500)	2.7×10^4	5.0×10^5 (1400)	8.9×10^4	2.0×10^4 (1030)	3.9×10^4	—	—	—	—	
12.4.79	—	—	—	—	—	—	1.3×10^6 (0935)	1.3×10^4	1.4×10^4 (1145)	—	2.6×10^2 (1300)	—	0546 4.5m 1201 0.8m 1805 4.7m
3.5.79	—	—	—	—	—	—	4.9×10^6 (1500)	1.3×10^4	5.4×10^3 (1015)	—	2.0×10^2 (1220)	—	0308 1.5m 0939 3.9m
	—	—	—	—	—	—	—	—	3.5×10^3 (1330)	—		—	1525 2.0m 2146 3.7m
17.5.79	—	—	—	—	—	—	—	—	4.9×10^2 (1645)	—	3.3×10^2 (1545)	—	0301 1.0m 0918 4.4m 1521 1.5m 2118 4.2m

[1] Most probable index per 100 ml.
[2] Most probable index per gram.

TABLE 2

Water quality of Kelang River and its estuary. (Blanks denote tests not performed)

Date	Station / Parameters	I	II	III	IV	V	VI
12.1.79	pH	6.9	6.8	6.9	7.1	—	—
	Total suspended solids, g/1	0.022	4.62	0.15	2.72	—	—
	Dissolved oxygen, mg/1	7.9 ± 0.1[1]	1.3 ± 0.1	nd[2]	1.2 ± 0.1	—	—
	Biological oxygen demand, mg/1	0.8 ± 0.1	22.9 ± 0.2	28.5 ± 1.5	16.7 ± 1.1	—	—
	Conductivity, μmho	21	240	250	270	—	—
	Time	1500	1630	1615	1145	—	—
15.2.79	pH	6.8	6.8	6 9	7.1	—	—
	Total suspended solids, g/1	0.015	2.67	0.31	2.79	—	—
	Dissolved oxygen, mg/1	7.2 ± 0.2	0.8 ± 0.1	1.1 ± 0.1	nd	—	—
	Biological oxygen demand, mg/1	nd	23.0 ± 0.1	29.1 ± 1.3	26.8 ± 1.1	—	—
	Conductivity, μmho	20	300	250	270	—	—
	Time	1310	1600	1500	1015	—	—
15.3.79	pH	6.8	6.9	7.1	7.1	—	—
	Total suspended solids, g/1	0.022	1.60	0.17	7.39	—	—
	Dissolved oxygen, mg/1	7.9 ± 0.2	nd	1.6 ± 0.1	nd	—	—
	Biological oxygen demand, mg/1	2.8 ± 0.1	25.9 ± 0.5	29.7 ± 1.0	33.5 ± 2.1	—	—
	Conductivity, μmho	27	350	225	300	—	—
	Time	1245	1500	1400	1030	—	—
12.4.89	pH	—	—	—	6.9	6.8	7.6
	Total suspended solids, g/1	—	—	—	2.32	2.33	0.38
	Dissolved oxygen, mg/1	—	—	—	2.6 ± 0.1	nd	6.1 ± 0.1
	Biological oxygen demand, mg/1	—	—	—	9.8 ± 0.3	12.8 ± 0.8	nd
	Conductivity, μmho	—	—	—	240	15,000	33,000
	Salinity, ‰	—	—	—	—	11.90 ± 0.06	32.60 ± 0.46
	Time	—	—	—	0930	1145	1300

(Table 2 continued)

Date	Station / Parameters	I	II	III	IV	V	VI
3.5.79	pH	—	—	—	7.3	7.4	7.4
	Total suspended solids, g/1	—	—	—	2.53	0.23	0.31
	Dissolved oxygen, mg/1	—	—	—	nd	5.8 ± 0.2	5.2 ± 0.2
	Biological oxygen demand, mg/1	—	—	—	11.7 ± 0.4	2.4 ± 0.2	1.6 ± 0.02
	Conductivity, μmho	—	—	—	290	25,000	30,000
	Salinity, ‰	—	—	—	—	24.33 ± 0.33	30.19 ± 0.28
	Time	—	—	—	1500	1000	1220
3.5.79	pH	—	—	—	—	7.1	—
	Total suspended solids, g/1	—	—	—	—	0.24	—
	Dissolved oxygen, mg/1	—	—	—	—	3.0 ± 0.1	—
	Biological oxygen demand, mg/1	—	—	—	—	1.3 ± 0.2	—
	Conductivity, μmho	—	—	—	—	22,000	—
	Salinity, ‰	—	—	—	—	17.55 ± 0.17	—
	Time	—	—	—	—	1330	—
17.5.79	pH	—	—	—	—	6.9	6.9
	Total suspended solids, g/1	—	—	—	—	0.32	0.30
	Dissolved oxygen, mg/1	—	—	—	—	1.7 ± 0.1	6.4 ± 0.2
	Biological oxygen demand, mg/1	—	—	—	—	2.6 ± 0.1	1.7 ± 0.1
	Conductivity, μmho	—	—	—	—	24,000	32,500
	Salinity, ‰	—	—	—	—	21.53 ± 1.03	31.94 ± 0.50
	Time	—	—	—	—	1645	1545

[1] Standard error
[2] not detectable

Faecal coliform counts in the coastal waters of Penang and the Straits of Johore have been reported to exceed 1,800/100 ml and 18,000/100 ml respectively (Maheswaran, 1978). The average faecal coliform count at Station VI, South Port, Port Kelang was 260/100 ml. This indicates that the level of faecal coliforms at the estuary of Kelang River is much lower than that in the coastal waters of Penang and Johore. The reason is not clear. The upper reaches of Kelang River are being heavily polluted by sewage discharge and thus one would also expect heavy pollution at the estuary of Kelang River. Since large amounts of suspended solids were brought into the sea by Kelang River, the suspended solids may play an important role in causing the disappearance of faecal coliforms at the estuary of Kelang River.

The water quality analyses (Table 2) indicate that Station I is an unpolluted stream, while other stations are heavily polluted by siltation and organic wastes. High levels of suspended solids, biological oxygen demand, and low levels of dissolved oxygen are the characteristics of the Kelang River. During low tide, 2.33 g/1 of total suspended solids and 12.8 mg/1 BOD were observed at the estuary at Station V; dissolved oxygen concentration was undetectable. This indicates that pollution arising from domestic effluents, agro-base industrial wastes and siltation in Kelang River may have caused some stress on the biota in its estuary.

High counts of faecal coliform were detected in the sediment of all the stations on the river except in Station I. The average concentration in Stations, I, II, III and IV was 17.9/g, 1×10^4/g, 3.2×10^4/g and 1.6×10^4/g respectively. There is a large amount of sediment in Kelang River. One may conclude that there is an excessive amount of faecal coliforms associated with the sediment. These faecal coliforms which are bound to the sediment will eventually reach the estuary and pollute the marine environment. The concentration of faecal coliforms in the sediment at the estuary was not determined because of the lack of sampling facilities. Further study is required in this area.

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