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Water Quality Profile of Sg. Langat

ANHAR SUKI, MOHD KAMIL YUSOFF and MOK THEAN POE
Department of Environmental Sciences
Faculty of Science and Environmental Studies
Universiti Pertanian Malaysia
43400, Serdang, Selangor, Malaysia.

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ABSTRAK

Kajian ini telah dijalankan pada bulan Ogos hingga Disember 1985 yang bertujuan untuk menilai kesan-kesan pencemaran yang berpunca daripada corak penggunaan tanah yang berlainan atas kualiti air sungai. Sebanyak sembilan lokasi penyempelan telah dipilih sepanjang 60 km bermula dari hulu sungai. Beberapa parameter fizikal dan kimia telah diukur. Ujian statistik dan Indeks Kualiti Air diguna untuk menentukan perubahan kualiti air. Keputusan kajian menunjukkan nilai-nilai BOD, pepejal terampai, pengkonduksian elektrik dan kekeruhan meningkat selepas bandar Hulu Langat. Ujian statistik menunjukkan perubahan kualiti air sangat bererti ($p < 0.05$). Berdasarkan Indeks Kualiti Air, kualiti air sungai yang berhampiran bandar Kajang menurun dengan ketara jika dibandingkan dengan lokasi yang lain.

ABSTRACT

This study was conducted between August and December 1985 in order to assess polluting effects from different landuse patterns. Nine sampling sites were chosen over a distance of 60 km. A number of physical and chemical parameters were analysed. Statistical tests and Water Quality Index were used to evaluate the water quality variation. The result shows that relatively high BOD, suspended solids, electrical conductivity and turbidity occurred after Hulu Langat town. The statistical test indicated that the water quality variation is significantly different ($p < 0.05$); the Water Quality Index shows that the water quality near Kajang town has deteriorated compared to other stations.

INTRODUCTION

Water serves a multitude of uses. As the various uses have grown in diversity, constrained by the more or less fixed quantity available, significant interaction of uses and reuses of water has also developed. Water quality is a very broad term when used by some people and quite specific for others and is the complementary aspect of water quantity (Biggar, 1979).

Chemically pure water rarely occurs in nature. Its content varies largely from region to region, and is a reflection of the local geography and climate (Hynes, 1970). According to Tanji (1979), water is often referred to as a universal solvent and because of this solvent power, it tends to pick up impurities as it comes into contact with gases, liquids and solids. Water in the hydrologic cycle is highly mobile and acts as a conveyor which then transports the pollutant downstream (Tanji, 1979). The solvent power and the mobility of water are the basic reasons why we have water pollution problems in rivers or any water bodies.

In a developing country like Malaysia, rapid changes are continually taking place. These include population growth, urbanisation, agricultural, mining and logging activities, and industrialisation.

Key to authors' name: A. Suki; M. Kamil; T.P. Mok

These changes bring about complex environmental problems and the most important natural resource that is affected is water (Abu Bakar, 1985). The development of land and natural resources, and the discharge of waste products into the water body are the main water pollution sources in Malaysia.

In the early days the water quality of Sg. Langat was of little concern as demand for water was relatively low. Now, with increased demand for water by the growing population, industry and agricultural sectors, there is an increased pollution load in the river, and this affects its uses (Mok, 1986). This study was carried out along Sg. Langat, to check on the variation in water quality with respect to landuse. Similar studies have also been carried out on other river systems. Law (1980), concentrated more on faecal coliform counts in Kelang River and Tan and Ng (1980), studied the effect of rubber effluent and domestic waste discharges into Gombak River and a tributary.

Basin Characteristics

The study area was confined to a catchment area of aproximately 700 sq. km within the Sg. Langat basin (*Figure 1*). The area is drained by Sg. Langat with its headwaters rising in the hills in the north and flowing generally southward towards the plains before turning westward towards the sea, covering a distance of approximately 120 km. The headwaters of the Sg. Langat is made up of forested foothills and rugged mountain ranges.

TABLE 1
A description of the sampling sites or stations.

Station	Distance from Estuary (km)	River width (m)
S1	118	9.9
S2	109	11.9
S3	105	14.7
S4	95	16.7
S5	92	17.3
S6	87	17.5
S7	81	18.0
S8	74	31.0
S9	60	31.0

Within the study area, there are six towns located along the river; Kg Kuala Panson, Dusun Tua, Hulu Langat, Cheras, Kajang and Dengkil (*Figure 2*). The largest town is Kajang, located in the middle section of the catchment area.

The landuse pattern is depicted in *Figure 1*. The basin comprises urban and associated areas, cultivation of rubber, oil palm, mixed horticulture and coconut, tin mining and forest reserve. Percentage wise, agricultural land and forest occupy 52 and 40 percent of the total acreage respectively (Mok, 1986).

Most of the industrial areas are located in Kajang and comprise various type of factories; the major factories being rubber, textile and paper mills (*Figure 2*).

MATERIALS AND METHODS

On-site surveys were carried out determine the potential sampling sites. The siting of the sampling site was based on accesibility and homogeneity in order to obtain a representative sample. Based on the above criteria, nine sampling sites were chosen (*Figure 2*). Table 1 shows the distance of the sampling sites from the estuary (at the river mouth).

Sampling of water from each site was carried out at a frequency of once a week from August to December 1985 for a duration of 12 weeks. For the purpose of this study, grab samples were collected for in-situ and laboratory analysis. In order to get a representative sample, the water sample was taken in the middle section of the river at 0.6 depth from the water surface (i.e 60% of the total depth).

The selected parameters for measurement were pH, temperature, dissolved oxygen (DO), electrical conductivity (EC), turbidity, suspended solids and biochemical oxygen demand (BOD). The first three parameters were determined on-site and the rest of the analysis were performed in the laboratory within 24 hours. Nutrient measurements were not carried out. Table 2 shows the analytical methods adopted throughout the study.

The analysis of variance (one way ANOVA) and Duncan Multiple Range tests were used to detect the significant difference of means between sampling sites (Steel and Torrie, 1960). The interpretation of variation in water quality was evaluated with the Water Quality Index (Norhayati, 1981).

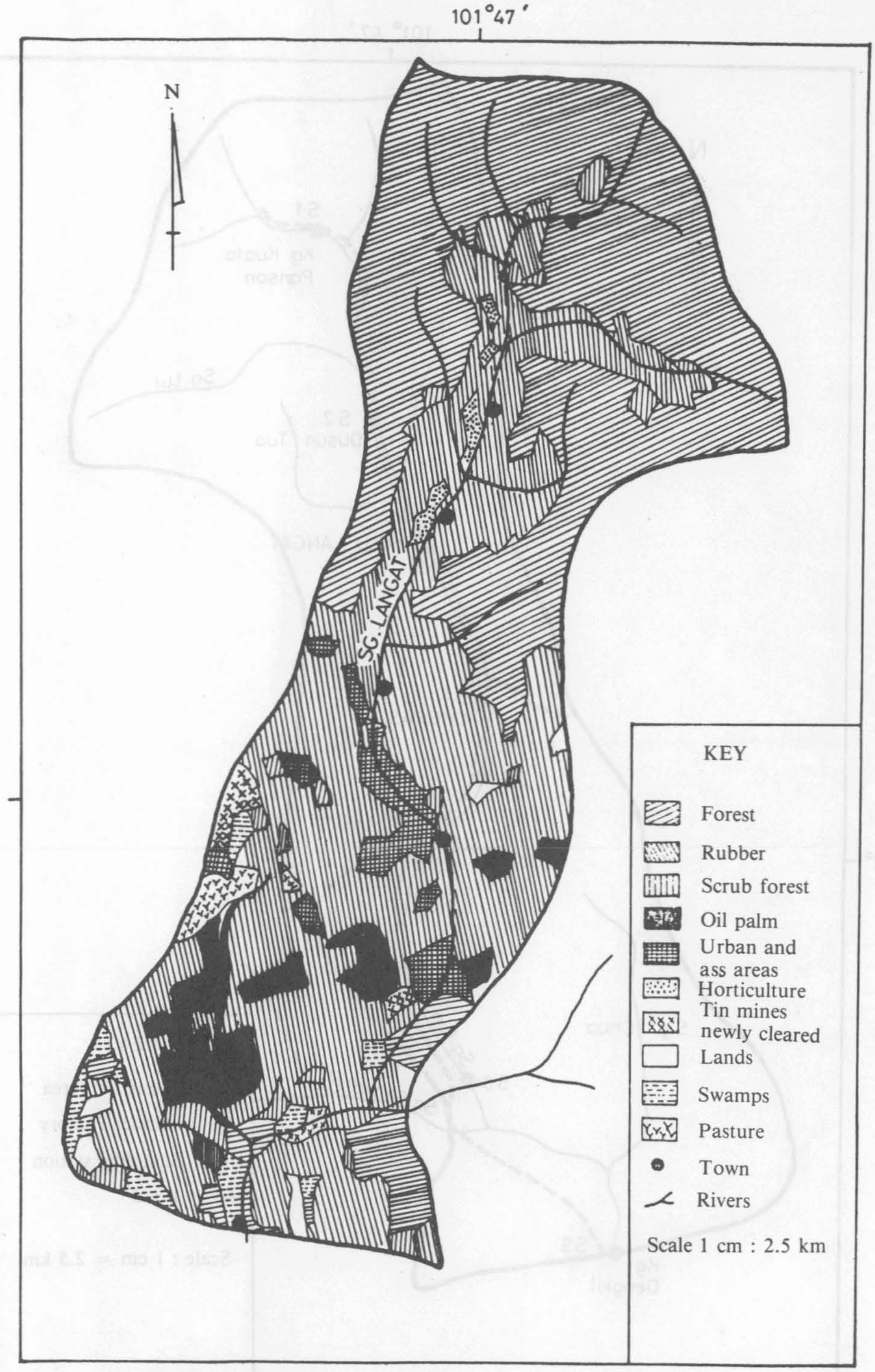

Fig 1. Landuse pattern in the study area.

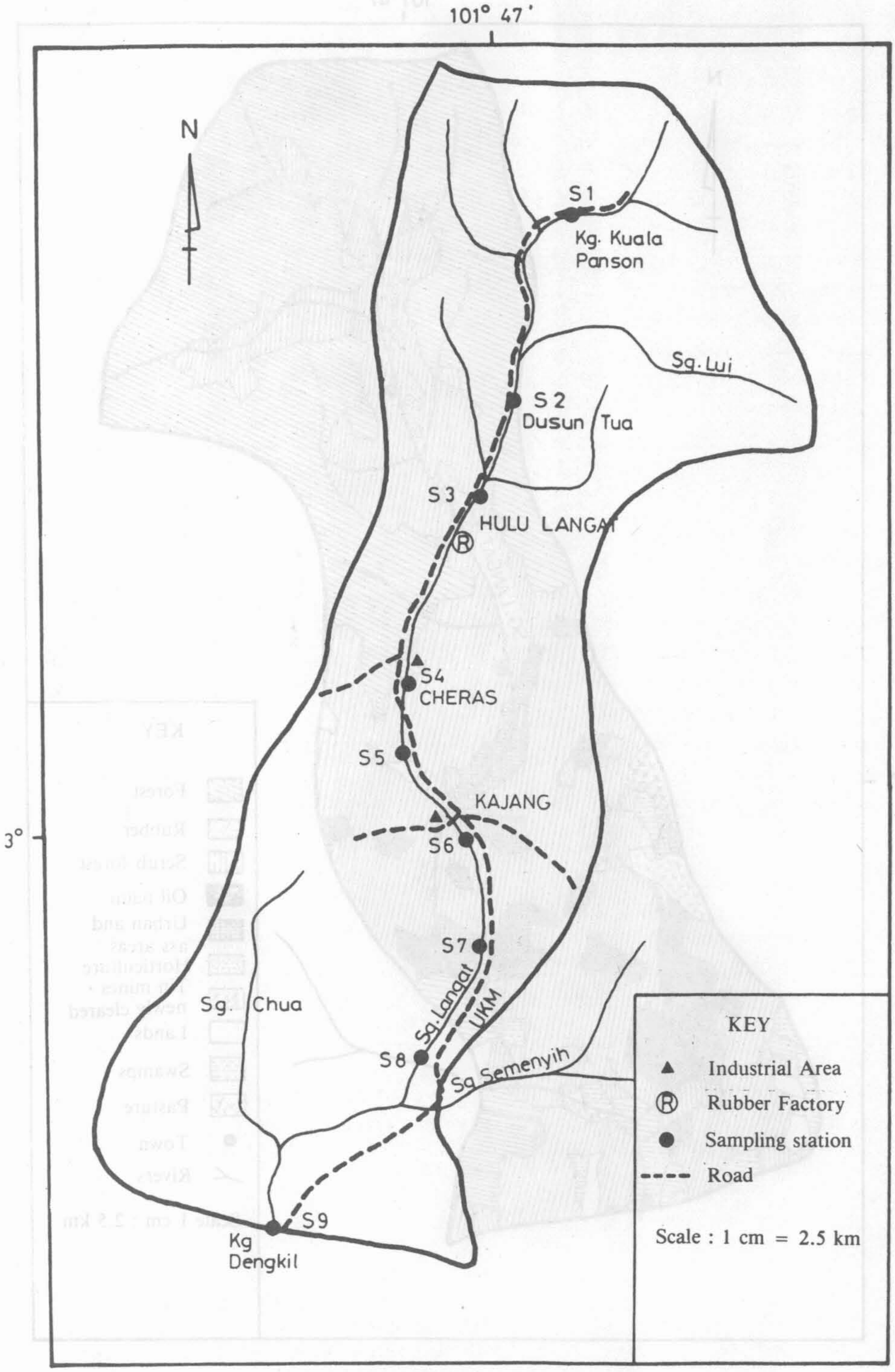

Fig 2. Location of sampling sites.

RESULTS AND DISCUSSION

BOD and DO

The average DO profile for the period of study is given in *Figure 3.* As shown, the dissolved oxygen value varies from 8.1 to 6.1 mg/l. Statistical analysis shows that the mean DO at each sampling station is significantly different ($p < 0.05$). At the upstream regions (Sampling station S1–S3), the value is above 7.8 which represents greater than 95% saturation. This is expected as the river in the upper region is mainly shallow and turbulent allowing ample reaeration. There is also limited organic pollution load in that section of the river as the area is mainly covered by rubber plantation and forest. The BOD value is on average less than 1.0 mg/l. This compares well with data obtained by the Department of Environment (1980–1984).

Further downstream the DO value reduces to 6.9 mg/l near Cheras area and to 6.2 mg/l at Kajang Town. The latter represents a reduction of the dissolved oxygen content by as much as 23% as compared to the upstream region (S1). The built-up areas from Cheras to Kajang town contribute to the increase in organic load particularly via the open drains. There is also a rubber mill downstream of Hulu Langat town and a paper and a textile mill at Kajang town. These industries

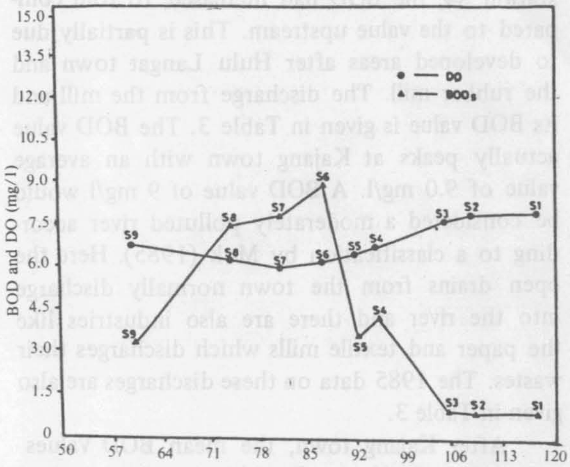

Fig 3. BOD and DO values for the various sampling sites.

also contribute to the increase in pollution load (Table 3). Beside these, there are also a number of other small industries and several saw mills along the river.

The BOD values were also obtained along the river. The statistical analysis shows that the mean values between each sampling station were found to be very significantly different ($p < 0.01$). This is also true for the other parameters discussed below. There is a distinct increase in the BOD value after sampling station S3. (*Figure 3*) At

TABLE 2

Analytical methods adopted

Parameter	Method of analysis
pH	Orion digital pH meter model 201 with glass electrode (± 0.1 pH unit)
Temperature	Thermistor probe (YSI 58) (±0.3)
Dissolved oxygen	Dissolved oxygen meter model YSI 58 (±0.1 mg/l)
Turbidity	Turbidimeter (HACH Model 2100A) (±2% of the full scale:- Ranges:- 0 – 0.1 NTU; 0 – 1.0 NTU; 0 – 10 NTU; 0 – 100 NTU; 0 – 1000NTU)
Electrical conductivity	Digital conductivity meter model PCM 3 (± 0.01 umhos/cm)
Suspended solids*	Filtration with Whatman glass microfibre filters
BOD*	Azide modification of the Winkler method and incubation time of 5 days at 20 C.

* – – – APHA, 1975

station S4, the BOD had increased 10 fold compared to the value upstream. This is partially due to developed areas after Hulu Langat town and the rubber mill. The discharge from the mill and its BOD value is given in Table 3. The BOD value actually peaks at Kajang town with an average value of 9.0 mg/l. A BOD value of 9 mg/l would be considered a moderately polluted river according to a classification by Mok (1985). Here the open drains from the town normally discharge into the river and there are also industries like the paper and textile mills which discharges their wastes. The 1985 data on these discharges are also given in Table 3.

After Kajang town, the mean BOD values decreases and at sampling station S9 the value has dropped to an average of 3.2 mg/l. This is due to the reduction in urban activity downstream and the absence of other major pollution sources. The DO as expected did not increase immediately and has a minimum value at station S7. This is due to the time taken for biological activity to reduce the oxygen content of the water. The Streeter-Phelps equation which calculates oxygen deficit in rivers due to organic pollution also predicts a similar profile (Metcalf and Eddy Inc. (1979)).

It is interesting to note that a BOD of 9.0 mg/l at Kajang represents an organic mass transport of about 68 kg/h (assuming lowest streamflow for the period of study (Table 4) and the input from the two major mills (paper and textile) at Kajang is about 4 kg/h (using data from Table 3). This rough calculation shows that the major organic input to Sg. Langat comes from other non point sources. It is suspected that the drain serving the developed areas are the main contributers.

Turbidity and Suspended Solids

The suspended solids and turbidity results are shown in *Figure 4.* The trend obtained with respect to distance is similar to that obtained for BOD and DO. Stations S1, S2 and S3 have lower suspended solids as the area is mainly covered by forest. As such there is little erosion occuring. This result is also reflected in the low turbidity values. The suspended solids value of less than 26 mg/l is in the class of good quality water which requires little or no treatment for potable use.

The suspended solids and turbidity are expected to rise as the river flows past developed and developing areas from Cheras and Kajang town. The mean suspended solids value at station S8 is a high 377 mg/l. This represents more than a 10 fold increase compared to the

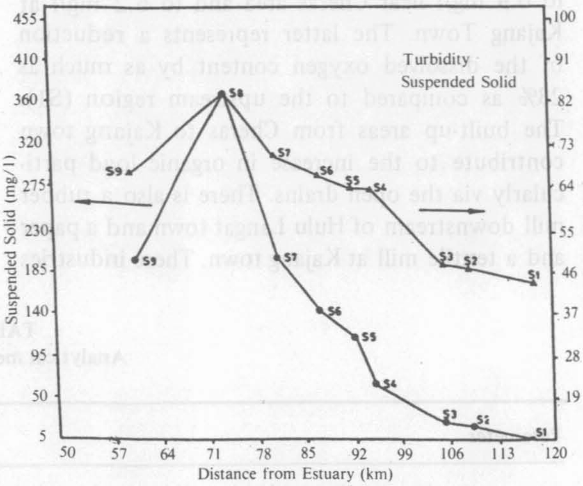

Fig 4. Suspended solids and turbidity values for the different sampling sites.

TABLE 3

Characteristics of industrial effluents in the study area

Type of Factory	Discharge (m3/day)	Average Monthly Suspended solid (mg/l)	Concentration BOD (mg/l)
Rubber	256	34	189
Textile	360	236	55
Papermill	246	20	265

Source: Department of Environment (1985)

TABLE 4
Weekly river discharge at Kajang (S6) and Dengkil (S9)

Month	Station Kajang (S6) (cumecs)	Dengkil (S9) (cumecs)
August	3.0	10.1
	2.1	7.4
	3.7	5.5
	3.0	4.9
September	7.7	5.7
	2.7	5.7
	2.6	6.0
	3.4	15.5
October	7.5	36.5
	4.4	18.5
	3.5	34.2
	4.3	35.4
November	18.8	63.3
	21.4	71.8
	17.3	63.4
	15.8	57.8

Source: Mok (1986)

value at S1 to S3. Between S6 and S8, developmental projects are underway. These include land clearing and housing development. As such the suspended solids and turbidity continue to rise.

At station S9, the suspended solids decrease in concentration. This last station is about 14 km from S8, and the area is mostly palm oil plantation, forest and swamps. Therefore there is little additional input of solids and sedimentation would reduce the settleable component. Two tributaries namely Sg. Chua and Sg. Semenyih join the Sg Langat 4 km and 9 km upstream of station S9. These two factors partially explain the reduction in the suspended solids values.

Electrical Conductivity (EC)

The results are given in *Figure 5.* The electrical conductivity range from 33 to 88 uS/cm. This is considered low and does not affect the water quality, as river water has an EC value of between 50 to 150 uS/cm. The EC trend downstream is similar to the other parameters as given above.

pH and Temperature

The mean pH for the various sampling stations range from 6.3 to 6.8 (*Figure 6*). This is a relatively narrow range and well within the pH of natural waters. Even though the range is small, the mean at each station was found to be significantly different ($p < 0.01$). The temperature of the sampling points are approximately constant, ranging from 26 to 28°C. The variation is mainly due to the time of sampling rather than any real difference between the sampling stations. The sampling was carried out from morning to evening.

Water Quality Index (WQI)

The water quality index can be computed using the various mathematical equations. For example

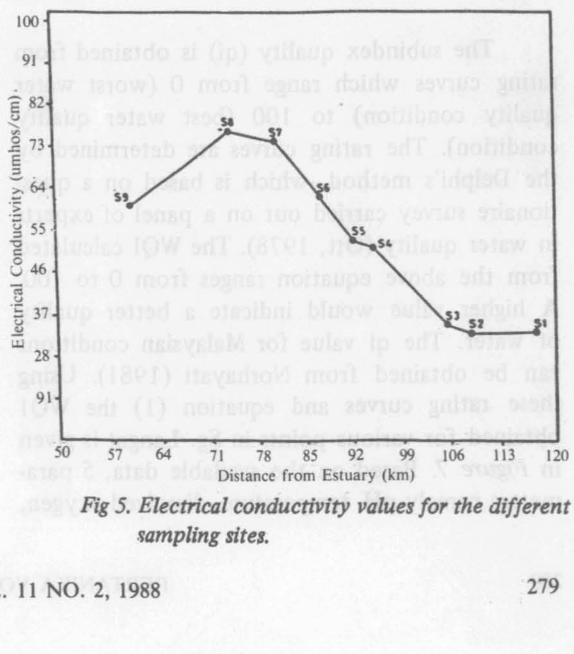

Fig 5. Electrical conductivity values for the different sampling sites.

the water quality index can be based on a weighted or unweighted arithmetic mean, weighted or unweighted geometric mean of partially weighted arithmetic or geometric mean (Horton, 1965 and; Ball and Church, 1980). The easiest to use is probably the arithmetic mean which can be given as (Ott, 1978);

$$WQI = \frac{1}{n} \sum_{i=1}^{n} qi \qquad (1)$$

where – qi is the quality of the i th parameter (subindex quality) and;

– n is the number of parameter to be included.

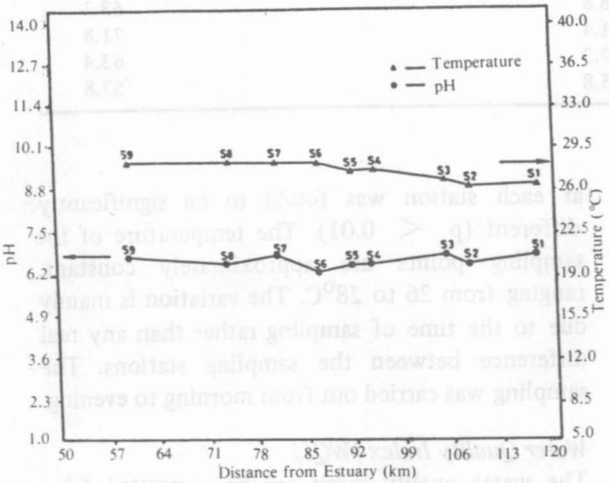

Fig 6. pH and temperature values for the different sampling sites.

The subindex quality (qi) is obtained from rating curves which range from 0 (worst water quality condition) to 100 (best water quality condition). The rating curves are determined by the Delphi's method, which is based on a questionaire survey carried out on a panel of experts in water quality (Ott, 1978). The WQI calculated from the above equation ranges from 0 to 100. A higher value would indicate a better quality of water. The qi value for Malaysian conditions can be obtained from Norhayati (1981). Using these rating curves and equation (1) the WQ1 obtained for various points in Sg. Langat is given in *Figure 7.* Based on the available data, 5 parameters namely pH, temperature, dissolved oxygen,

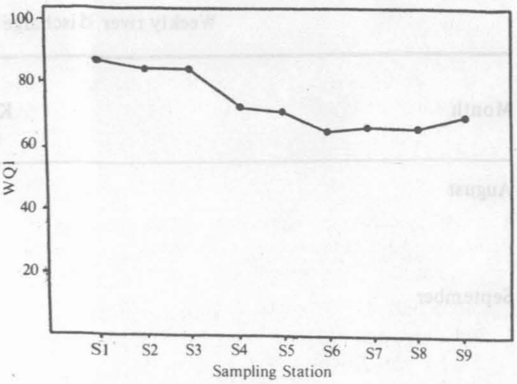

Fig 7. WQI values for the various sampling sites.

BOD and suspended solids were used in the computation. The highest value of 87 is for station S1 and station S6 at Kajang has the lowest value i.e. 66. At the last station at Dengkil, the water quality appears to have recovered slightly. The water quality index gives a relative indication of the quality of the water along the river. A river with a WQI value in the ranges 0–31, 32–57, 58–78 and 79–100 would be considered grossly, moderately, slightly polluted and clean respectively. Using this classification, the river would only be termed slightly polluted at Kajang. However, these are only rough indications and the divisions are rather subjective.

CONCLUSION

The results show that the changes in water quality of Sg. Langat can be explained by the landuse characteristics of the river basin. Similar trends with respect to distance were obtained for the various water quality parameters. The water quality at the upper catchment is very clean with a BOD less than 1.0 mg/l and DO at greater than 95% saturation. This makes the water a good source of potable water. Unfortunately the uptake for potable water supply is further downstream at Cheras (between S3 and S4) and another after Dengkil. The most polluted section of the river is between S4 and S8. This section includes the Kajang town, the worst point in the river. The organic loading to the river is mainly from non point sources rather than specific large industries. However, the discharges by the industries are significant.

REFERENCES

ABU BAKAR JAAFAR. (1985): The state of the environment in Malaysia: Public sector perspective. Paper presented at the Seminar *on the State of Environment Quality in Malaysia.* Kuala Lumpur. Ministry of Science, Technology and Environment. 8–11 July 1985.

APHA. (1975): Standard Methods for the Examination of Water and Wastewater. 14ed. Washington. American Public Health Association.

BALL, R.O and R.L. CHURCH (1980): Water quality indexing and scoring. *J. of the Environmental Engineering Division.* 105(4), 757–771.

BIGGAR, J.W. (1979): Soil and Water Salinity. Department of Land and Water Resources. University of California, Davis.

DEPARTMENT OF ENVIRONMENT. (1980–1984): River water quality data. (unpublished)

DEPARTMENT OF ENVIRONMENT (1985): Factory discharged data (unpublished).

HORTON, R.K. (1965): An index – Number system for rating water quality. *J. Water Poll. Control.* 37(3), 300–306.

HYNES, H.B.N. (1970): The Ecology of Running Waters. Toronto. University of Toronto Press.

LAW, A.T. (1980): Sewage pollution in Kelang River and its estuary. *Pertanika.* 3(11), 13–19.

METCALF AND EDDY INC. (1979): Wasterwater Engineering: Treatment Disposal and Reuse. Second edition. New York. McGraw-Hill Book Co.

MOK, T.P. (1986): Water quality changes in Sg. Langat. B.Sc.(Env.). Project Report 1985/86. Universiti Pertanian Malaysia. 108 p.

NORHAYATI MUSTAPHA. (1981): Indices for water quality assessment in a river. Master's Thesis. Environmental Engineering Department. Bangkok. Asian Institute Technology.

OTT. W.R. (1978): Environmental Indices – Theory and Practice, Michigan. Ann Arbor Science, Ann Arbor.

STEEL, R.G.D. and J.H. Torrie (1960): Principles and Procedures of Statististics. New York. McGraw-Hill Book Company.

TAN, W.T. and B.S. NG, (1980): A chemical survey of the Batang Belungkung River and the Gombak River. *Pertanika.* 3(1), 40–46.

TANJI, K. (1979): Water quality and pollution. In Introduction to Water Science by Silk, W. *et al.*,. Department of Land and Water Resources. University of California, Davis.

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