Faculty of Resource Science and Technology

WATER QUALITY AND NUTRIENTS CONTENT OF THE WATERS IN BATANG SARIBAS

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ABSTRACT

This study was carried out to document the water quality and nutrients content of Batang Saribas, Sarawak. Water samples were collected from 5 selected stations, from the upstream (Station 5: Tanjung Serembang) to the downstream area (Station 1: Kampung Supa). The water quality parameters of Batang Saribas were DO (7.83 mg/l), BOD_5 (8.56 mg/l), pH (7.61), temperature (33.1 °C), salinity (19 psu), transparency (19 cm), TSS (654.89 mg/l), orthophosphate (0.04 mg/l), nitrate (0.08 mg/l) and ammonia-nitrogen (2.28 mg/l). The water quality of Batang Saribas was slightly polluted.

Key words: Water quality, nutrients content, tidal, Batang Saribas

ABSTRAK

Kajian ini dijalankan bagi mengenalpasti kualiti air dan kandungan nutrien yang terdapat di Batang Saribas, Sarawak. Pensampelan dilakukan di 5 stesen yang telah ditentukan iaitu dari bahagian hulu (Stesen 5: Tanjung Serembang) hingga bahagian hilir (Stesen 1: Kampung Supa). Parameter kualiti air dan kandungan nutrien adalah DO (7.83 mg/l), BOD_5 *(8.56 mg/l), pH (7.61), suhu (33.1 °C), kemasinan (19 psu), tranparensi (19 cm), TSS (654.89 mg/l), orthofosfat (0.04 mg/l), nitrat (0.08 mg/l) dan ammonia-nitrogen (2.28 mg/l). Melalui kajian ini, kualiti air di Batang Saribas adalah sederhana tercemar.*

Kekunci kata: *Kualiti air, kandungan nutrien, pasang surut, Batang Saribas*

- Water quality,
- Water quality -- Measurement.

INTRODUCTION

River is a large natural flow of water traveling along a channel to the sea. Rivers are the most important transportation in rural Sarawak and place for economic resources. Human and other organisms using river water for their main sources of drinking water supply, agricultural and recreation activities.

Nowadays, many rivers are polluted with household rubbish, oil spills and high level of suspended solids in the water bodies. All of these happen because of human activities such as construction, logging activities near the river, urban development and industrial activities that have negative impact on the river water quality and the nutrients content (Pereira, 1998). In the river, there are many indigenous fishes and which also the main sources of protein to the human. If water quality deteriorates, fishes and other aquatic organism may eventually go extinct.

Therefore, comprehensive baseline data on the water quality and nutrients content are important in order to provide sufficient information that can be used for future reference in regulatory, monitoring, maintenance and development planning of Batang Saribas. Based on the data collected, the pollutant sources can be identified and this may reduce the adverse impacts to the water bodies.

Rivers are one of the main sources of drinking water (Pimentel *et al.*, 1997). The necessity to provide high quality drinking water is continuously challenged by the increasing number of substances that enter the river systems (Sabater *et al.*, 2002). Water quality is defined as the summation of all physical, chemical, biological and aesthetic characteristic of water that influences its beneficial use (Boyd and Tucker, 1998). The parameters are pH, temperature, dissolved oxygen (DO) and biological oxygen demand (BOD_5) (Dunnette and O'Brien, 1992). Other parameters that are important include total suspended solid (TSS), chlorophyll a and salinity. The pH is a negative logarithm of the hydrogen ion which is essentially equally to the hydrogen ion concentration (APHA, 1998). The condition becomes more acid as pH value decreases and more basic as pH increase (Landau, 1992). Normally pH values in natural water range from 6.5 to 9.0 and if pH level out of this range may have impacts on aquatic organisms (Suksomjit *et al.*, 1998). Water temperature is the important variable affecting the aquatic production. It affects the natural productivity of the aquatic ecosystems and directly or indirectly affects all other water quality variables (Boyd and Tucker, 1998). According to Rand *et al.*, 1995), the dissolved oxygen (DO) is one of the most important factors in the aquatic environment. DO is essential for respiration and plays an important role in regulating metabolic and other physiological process. The biological oxygen demand (BOD_5) is the amount of oxygen required by bacteria to decompose aerobically an amount of organics matter in a given of period of time at a stated temperature (Nemerow, 1974). According to Dojlido and Best (1993), the suspended solids discharged to rivers in domestic sewage, waste water, storm water and excessive algal growths in the water is the results of the presence of nutrients and sunlight. In brackish waters and estuaries, a change in salinity is another factor influencing the increasing nutrients (Lawson, 1995). When salinity changed more than 10 % within a few minutes or hours, fish and invertebrate may not be able to compensate this changed (Boyd, 1990).

Water quality parameters are very important, but study is not complete without data collections of nutrients. The nutrients content is important to the aquatic organisms such as fishes and plankton. Some of the nutrients are nitrate, phosphorus and ammonia (Stickney, 1979). If these elements are in the wrong molecular form, they cannot be used by plants and if they are present in high concentrations, they can damage the plants and animals rather than stimulate primary productivity (Landau, 1992). The nitrate (NO_3^-) is a common form of inorganic combined nitrogen in natural waters and aquaculture system (Boyd and Tucker, 1998). Most of the nitrate found in unpolluted natural waters is the end product of nitrification and considered the least toxic of all forms of combined inorganic nitrogen (Connel and Hawker, 1992). Ammonia (NH_3) arises as a rule from the aerobic or anaerobic decomposition of nitrogenous organic matter and if present in water in appreciable amounts provides strong presumptive evidence of the presence of sewage or animals wastes (Liong, 1984). Phosphorus, usually in the form of orthophosphate (PO_4^{-3}) is a critical nutrient for plants (Landau, 1992). According to Muscutt and Withers (1996), the enrichment of surface waters with phosphorus can have a large and undesirable impact on their tropic state, usage and appearance. These three nutrients (nitrate, ammonia and phosphorus), play an important role in defining the quality of rivers.

This study was carried out to investigate and document the water quality and nutrients content of the water of Batang Saribas around Kampung Manggut area.

MATERIALS AND METHODS

Study area and Sampling Station

This study was carried out in Batang Saribas (Figure 1), Betong Division, from 21 - 26 August, 2003. The length of Batang Saribas is 147 km and the catchment area is 1957 km^2 (Memon and Mohamed, 1999).

Five sampling stations were selected along the river. Kampung Manggut is at the center of the sampling stations. The sampling stations are Kampung Supa (Station 1) 111°18.126'E, 01°30.645'N, Tanjung Keranji (Station 2) 111°19.898'E, 01°30.529'N, Kampung Manggut (Station 3) 111°21.37'E, 01°30.50'N, Tanjung Baring (Station 4) 111°22.568'E, 01°30.315'N, and Kampung Serembang (Station 5) 111°23.643'E, 01.°28.817'N.

In each station, water samples were collected using Van Dorn bottle (2 L) from 3 depths of the river (surface, middle, bottom), during flood and ebb tides. In each depth, 3 replicates of water samples were collected.

Water Samples Analysis

Water parameters were analyzed, in-*situ* and at Unimas laboratory.

In-situ Analysis

Dissolved oxygen (DO) and temperature values were measured using DO 300/310 CyberScan (Waterproof), pH was measured using pH meter, salinity was measured using Hand Refractometer Atago, and transparency was measured using the Secchi Disk.

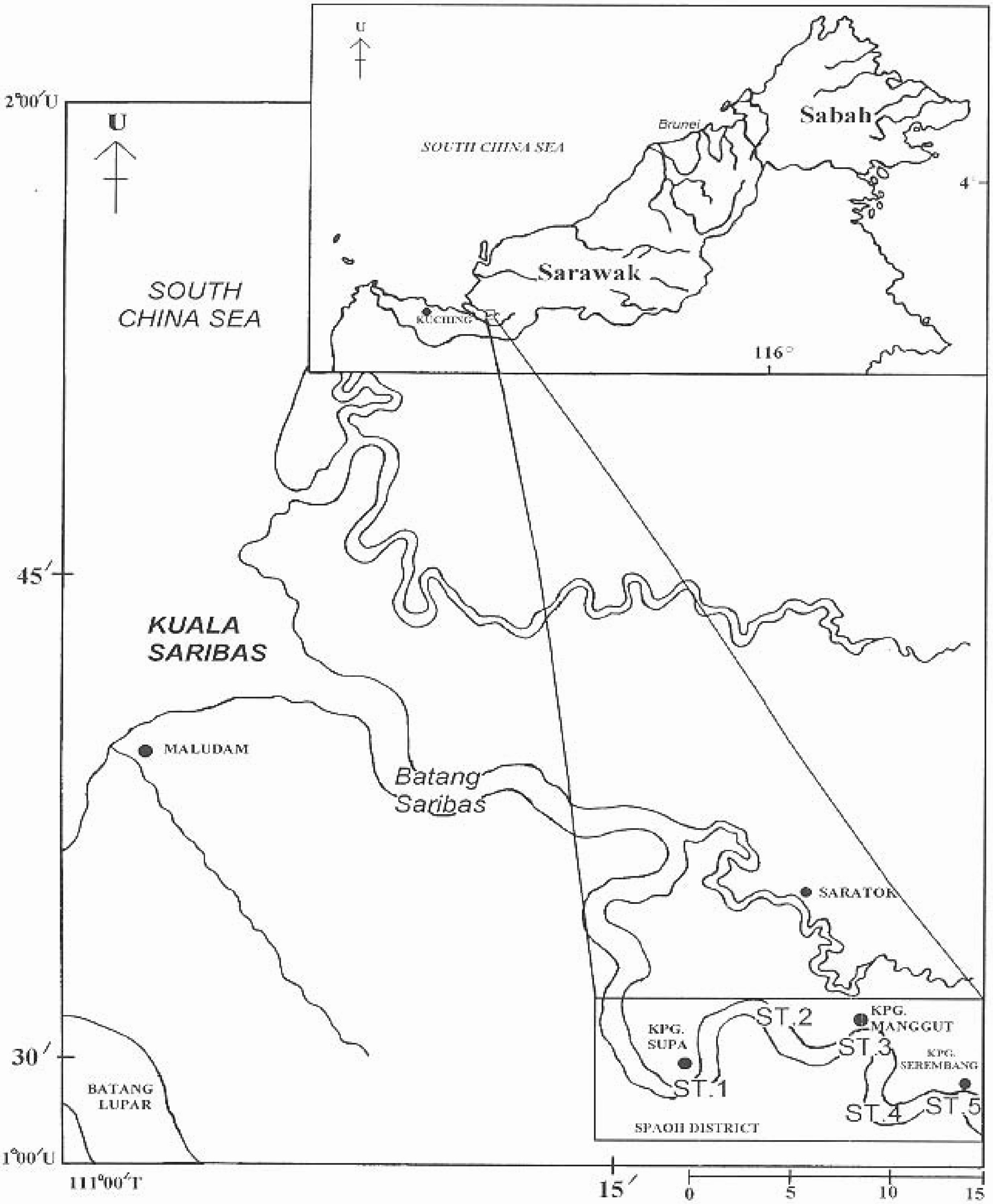

Figure 1: Location of sampling stations along Batang Saribas.

Laboratory Analysis

Biological oxygen demand (BOD_5), total suspended solid (TSS) and nutrient analysis was conducted in the Aquatic laboratory of UNIMAS.

Biological Oxygen Demand (BOD_5)

Biological oxygen demand was measured using the procedure outlined in APHA (1998). The initial dissolved oxygen in the BOD bottle (300 mL and 250 mL) was measured and recorded. Then, the BOD bottles were wrapped with aluminum foil and stored at 25 °C. The value of dissolved oxygen was taken after 5 days. Biological oxygen demand was calculated as the measurement of the differences between the initial and final dissolved oxygen in the water. The formula to calculate BOD_5 is as given below:

$$\mathbf{BOD_5}\ \mathbf{, (mg/l)} = \frac{\mathbf{D_1 - D_5}}{\mathbf{P}}$$

D_1 = DO of diluted sample immediately after preparation (mg/l)

D_5 = DO if diluted sample after 5 day incubation at 25 °C (mg/l)

P = decimal volumetric fraction of sample used (l)

Total Suspended Solid (TSS)

The standard method of APHA (1998) was used to measure the total suspended solids. A 0.45 μm membrane filter was dried at a temperature of 103 °C and 105 °C and weighed. Then 150 mL of the sample was filtered through the membrane filter. The membrane filter with the residue was then dried with the same temperature and weighed until reaching a constant weight.

The increased weight represented the total suspended solids of the samples. The formula to calculate TSS is as given below:

$$\textbf{TSS (mg/l)} = \frac{\textbf{(A – B) x 1000}}{\textbf{Sample volume (ml)}}$$

A = weight of dried residue + filter (mg)

B = weight of filter (mg)

Nutrients Analysis

All the water samples were filtered before analysis of nutrient. Filtered water samples were stored in the refrigerator at 4 °C or below if samples were analyse within 24 to 48 hours. The samples were left to warm to the room temperature before analysis was conducted (Hach, 2000).

The concentration of phosphorus was determined following the standard method 8048 (0 to 2.50 mg/l PO_4^{3-}). Orthophosphate reacts with molybdate in an acid medium to produce a phosphomolybdate complex. Ascorbic acid then reduces the complex and give an intense molybdenum blue color (Hach, 2000).

The concentration of nitrate was determined following the standard method 8192 (0 to 0.40 mg/l NO_3-N). Cadmium metal reduces nitrates present in the sample to nitrite. The nitrite ion reacts in an acidic medium with sulfanilic acid to form an intermediate diazonium salt, which couples to chromotropic aced to form a pink colored product (Hach, 2000).

The concentration of ammonia-nitrogen was determined following the standard method 8038 (0 to 2.50 mg/l NH_3-N). The Polyvinyl Alcohol Dispersing Agent aids the color formation in the reaction of Nessler Reagent with ammonium ions. A yellow color is formed proportional to the ammonia concentration (Hach, 2000).

RESULTS

The values of pH, DO, temperature, salinity and transparency recorded from 5 stations at three different depths are shown in Table 1.

At Station 1, the pH values ranged from 7.31 to 7.36 during flood tide and 6.77 to 6.84 during ebb tide (Table 1 and Figure 2a). At Station 2, the pH values ranged from 7.51 to 7.61 during flood tide and 7.28 to 7.32 during ebb tide (Table 1 and Figure 2b). At Station 3, the pH values ranged from 7.27 to 7.31 during flood tide and 7.17 to 7.20 during ebb tide (Table 1 and Figure 2c). At Station 4, the pH values ranged from 7.32 to 7.35 during flood tide and 7.01 to 7.09 during ebb tide (Table 1 and Figure 2d). At Station 5, the pH values ranged from 7.22 to 7.26 during flood tide and 6.91 to 6.96 during ebb tide. (Table 1 and Figure 2e).

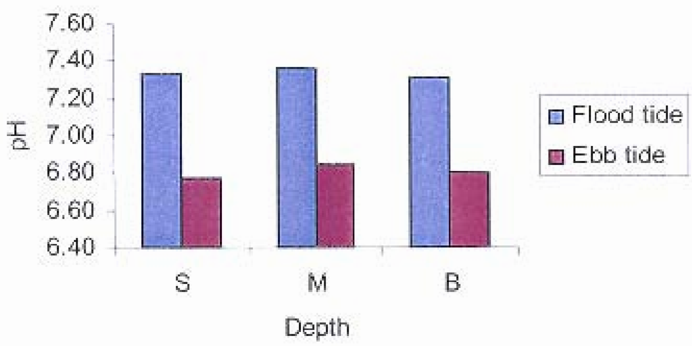

Figure 2a: Values of pH at different depths during flood and ebb tides for Station 1.
S=Surface; M=Middle; B=Bottom

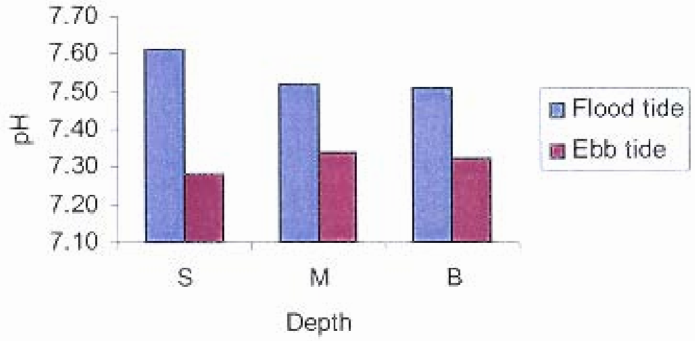

Figure 2b: Values of pH at different depths during flood and ebb tides for Station 2.
S=Surface; M=Middle; B=Bottom

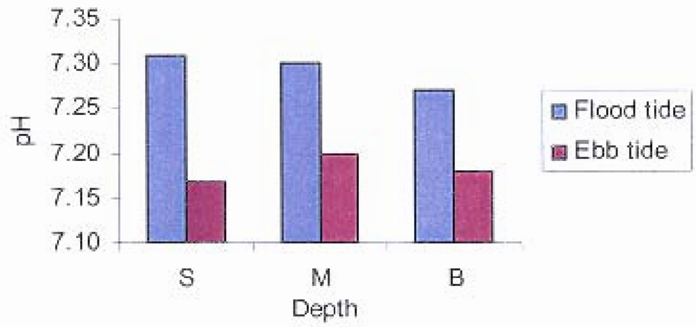

Figure 2c: Values of pH at different depths during flood and ebb tides for Station 3.
S=Surface; M=Middle; B=Bottom

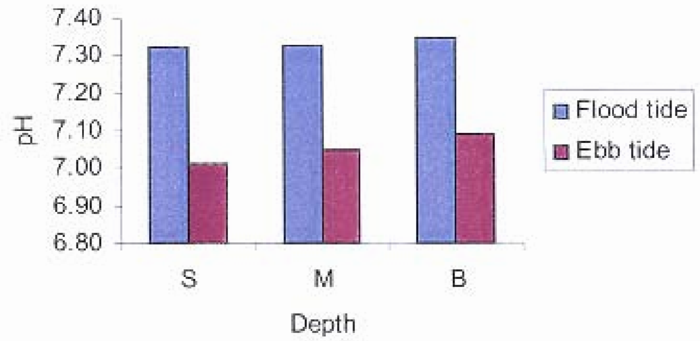

Figure 2d: Values of pH at different depths during flood and ebb tides for Station 4.
S=Surface; M=Middle; B=Bottom

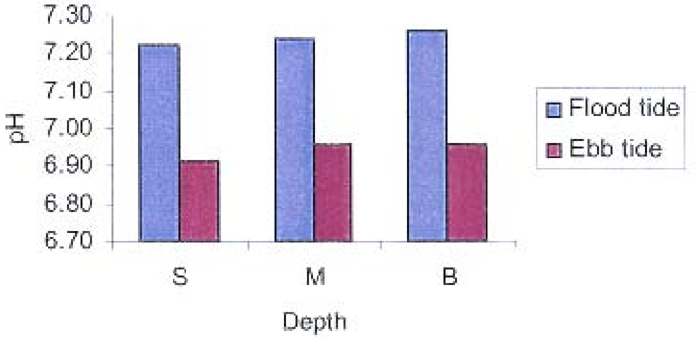

Figure 2e: Values of pH at different depths during flood and ebb tides for Station 5.
S=Surface; M=Middle; B=Bottom

Table 1: Result of various water quality parameters recorded at the sampling stations.

Date	Station	Time	Depth (m)		pH	DO (mg/l)	TEMP (°C)	SAL (psu)	Tran. (cm)
23.08.03	1	1040	9.7	S	7.33	5.39	33.1	18	49.5
	Kpg. Supa	Flood Tide		M	7.36	5.95	32.0	18	52.5
				B	7.31	6.24	30.7	19	48.6
23.08.03	1	1700	5.0	S	6.77	6.85	31.5	11	55.7
	Kpg. Supa	Ebb Tide		M	6.84	6.82	31.2	11	56.3
				B	6.80	6.87	31.0	11	56.2
23.08.03	2	1215	8.4	S	7.61	6.65	30.0	17	24.8
	Tjg. Keranji	Flood Tide		M	7.52	6.47	29.8	16	29.5
				B	7.51	6.45	29.7	18	27.7
25.08.03	2	1000	6.0	S	7.28	6.78	31.1	12	21.5
	Tjg. Keranji	Ebb Tide		M	7.34	6.74	30.3	12	22.2
				B	7.32	6.83	29.7	12	22.3
25.08.03	3	1635	9.5	S	7.31	7.00	30.5	12	39.7
	Kpg. Mangkut	Flood Tide		M	7.30	7.02	30.2	12	38.8
				B	7.27	7.03	30.1	12	37.8
25.08.03	3	1115	5.0	S	7.17	7.31	30.6	12	25.4
	Kpg. Mangkut	Ebb Tide		M	7.20	7.33	30.1	12	25.7
				B	7.18	7.31	29.9	12	25.4

22.08.03	4 Tjg. Baring	1300 Flood Tide	3.6	S	7.32	6.64	29.0	18	27.0
				M	7.33	6.61	29.0	18	25.8
				B	7.35	6.59	29.0	18	27.8
26.08.03	4 Tjg. Baring	1055 Ebb Tide	4.9	S	7.01	7.52	28.5	12	19.2
				M	7.05	7.20	28.6	12	19.0
				B	7.09	7.17	28.7	12	19.4
25.08.03	5 Tjg. Serembang	1515 Flood Tide	8.4	S	7.22	6.63	31.4	10	26.5
				M	7.24	6.81	30.5	10	26.8
				B	7.26	6.90	30.3	10	26.7
26.08.03	5 Tjg. Serembang	1000 Ebb Tide	4.1	S	6.91	7.83	27.2	12	19.8
				M	6.96	7.42	27.7	12	19.7
				B	6.96	7.24	28.1	12	19.6

At Station 1, the concentration of dissolved oxygen (DO) ranged from 5.39 mg/l to 6.24 mg/l during flood tide and 6.82 mg/l to 6.87 mg/l during ebb tide (Table 1 and Figure 3a). At Station 2, the concentrations of DO ranged from 6.45 mg/l to 6.65 mg/l during flood tide and 6.74 mg/l to 6.83 mg/l during ebb tide (Table 1 and Figure 3b). At Station 3, the concentrations of DO ranged from 7.0 mg/l to 7.03 mg/l during flood tide and 7.31 mg/l to 7.33 mg/l during ebb tide (Table 1 and Figure 3c). At Station 4, the concentrations of DO ranged from 6.59 mg/l to 6.64 mg/l during flood tide and 7.17 mg/l to 7.52 mg/l during ebb tide (Table 1 and Figure 3d). At Station 5, the concentrations of DO ranged from 6.63 mg/l to 6.90 mg/l during flood tide and 7.24 mg/l to 7.83 mg/l during ebb tide. (Table 1 and Figure 3e).

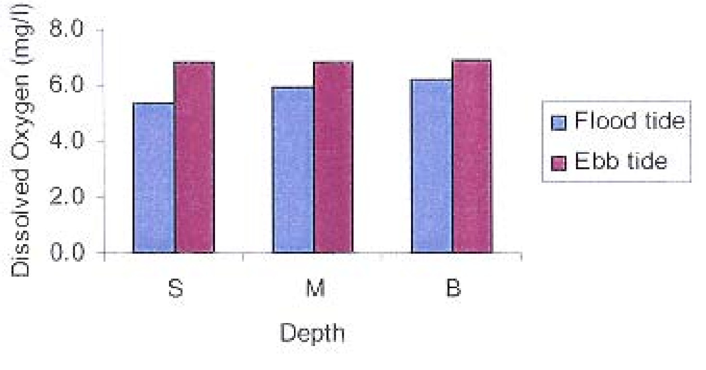

Figure 3a: Concentration of dissolved oxygen at different depths during flood and ebb tides for Station 1. S=Surface; M=Middle; B=Bottom

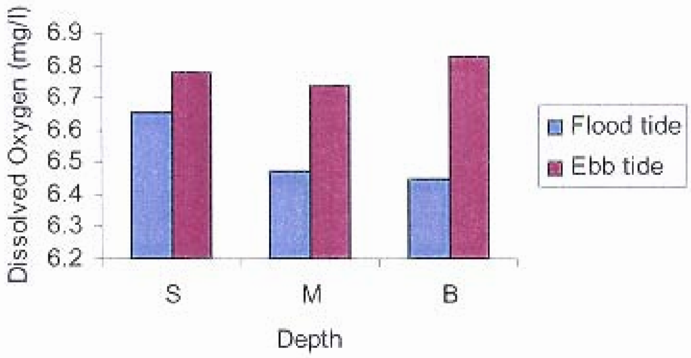

Figure 3b: Concentration of dissolved oxygen at different depths during flood and ebb tides for Station 2. S=Surface; M=Middle; B=Bottom

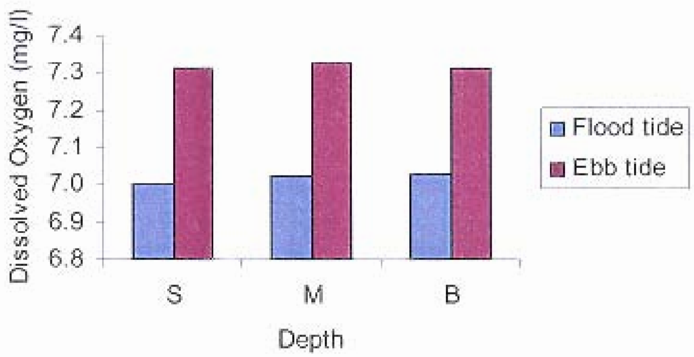

Figure 3c: Concentration of dissolved oxygen at different depths during flood and ebb tides for Station 3. S=Surface; M=Middle; B=Bottom

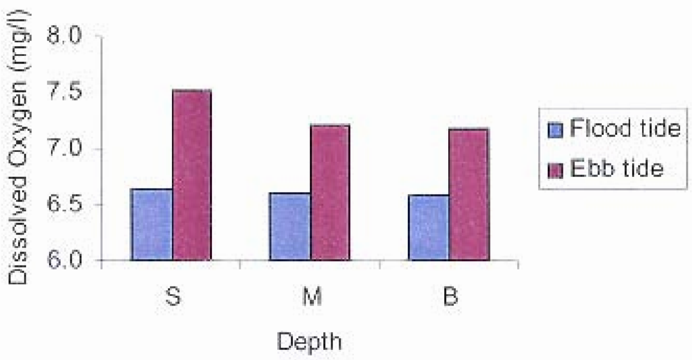

Figure 3d: Concentration of dissolved oxygen at different depths during flood and ebb tides for Station 4. S=Surface; M=Middle; B=Bottom

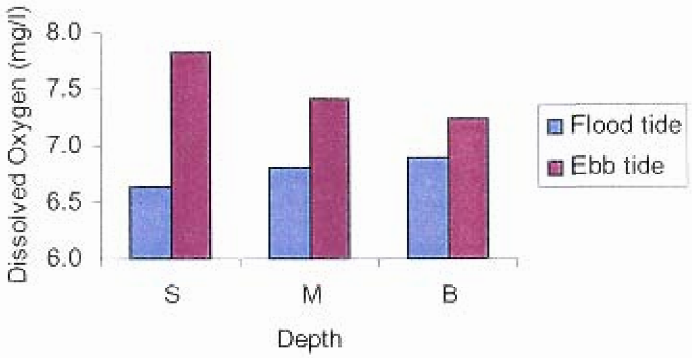

Figure 3e: Concentration of dissolved oxygen at different depths during flood and ebb tides for Station 5. S=Surface; M=Middle; B=Bottom

At Station 1, the temperature values ranged from 30.7 °C to 33.1 °C during flood tide and 31.0 °C to 31.5 °C during ebb tide (Table 1 and Figure 4a). At Station 2, the temperature values ranged from 29.7 °C to 30.0 °C during flood tide and 29.7 °C to 31.1 °C during ebb tide (Table 1 and Figure 4b). At Station 3, the temperature values ranged from 30.1 °C to 30.5 °C during flood tide and 29.7 °C to 30.6 °C during ebb tide (Table 1 and Figure 4c). At Station 4, the temperature value ranged was 29.0 °C during flood tide and 28.5 °C to 28.7 °C during ebb tide (Table 1 and Figure 4d). At Station 5, the temperature values ranged from 30.3 °C to 31.4 °C during flood tide and 27.2 °C to 28.1 °C during ebb tide (Table 1 and Figure 4e).

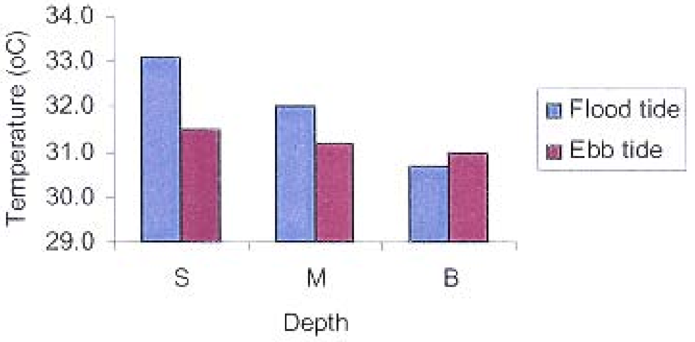

Figure 4a: Values of temperature at different depths during flood and ebb tides for Station 1.
S=Surface; M=Middle; B=Bottom

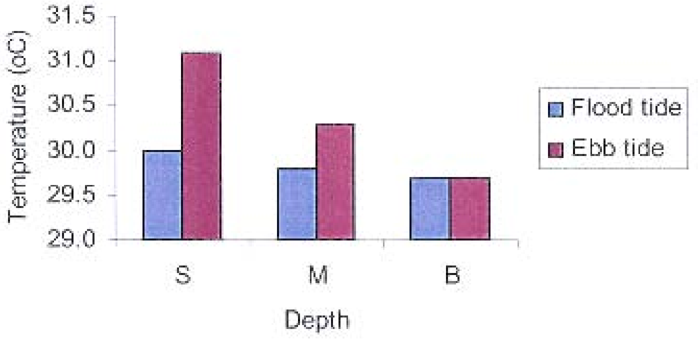

Figure 4b: Values of temperature at different depths during flood and ebb tides for Station 2.
S=Surface; M=Middle; B=Bottom

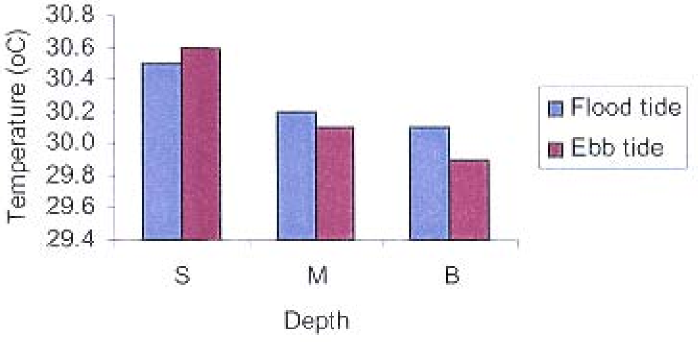

Figure 4c: Values of temperature at different depths during flood and ebb tides for Station 3.
S=Surface; M=Middle; B=Bottom

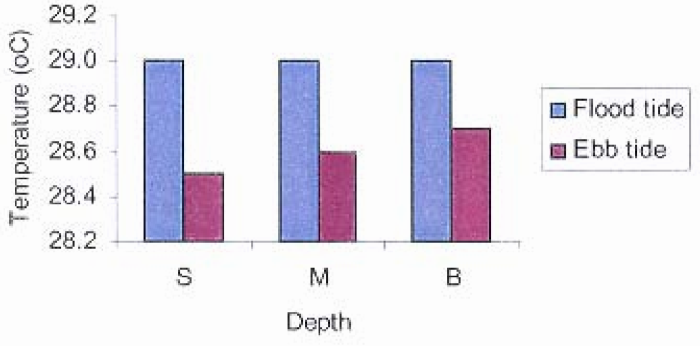

Figure 4d: Values of temperature at different depths during flood and ebb tides for Station 4.
S=Surface; M=Middle; B=Bottom

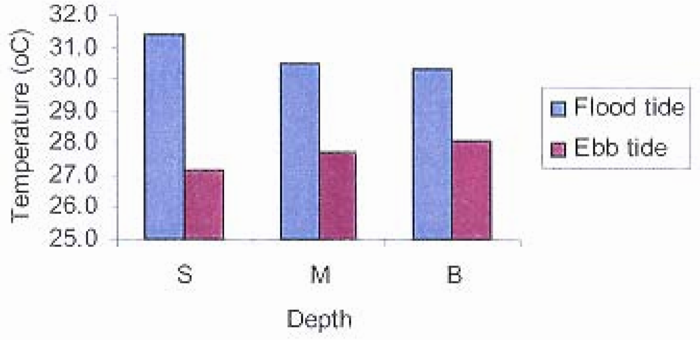

Figure 4e: Values of temperature at different depths during flood and ebb tides for Station 5.
S=Surface; M=Middle; B=Bottom

At Station 1, the concentration of salinity ranged from 18 psu to 19 psu during flood tide and 11 psu during ebb tide (Table 1 and Figure 5a). At Station 2, the concentration of salinity ranged from 16 psu to 18 psu during flood tide and 12 psu during ebb tide (Table 1 and Figure 5b). At Station 3, the concentration of salinity ranged was 12 psu during flood and ebb tide (Table 1 and Figure 5c). At Station 4, the concentration of salinity ranged was 18 psu during flood tide and 12 psu during ebb tide (Table 1 and Figure 5d). At Station 5, the concentration of salinity ranged was 10 psu during flood and ebb tides (Table 1 and Figure 5e).

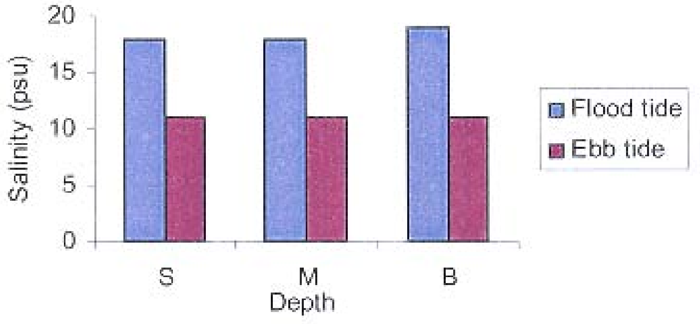

Figure 5a: Concentration of salinity at different depths during flood and ebb tides for Station 1.
S=Surface; M=Middle; B=Bottom

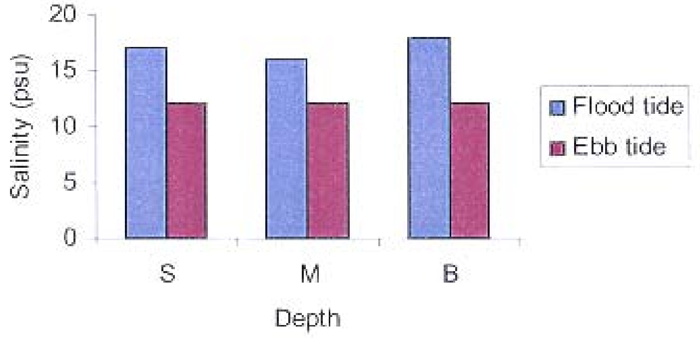

Figure 5b: Concentration of salinity at different depths during flood and ebb tides for Station 2.
S=Surface; M=Middle; B=Bottom

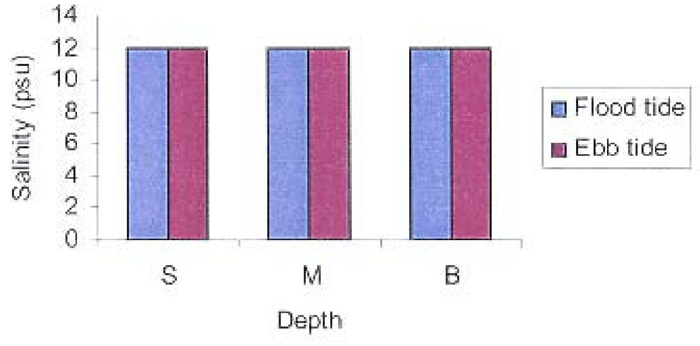

Figure 5c: Concentration of salinity at different depths during flood and ebb tides for Station 3.
S=Surface; M=Middle; B=Bottom

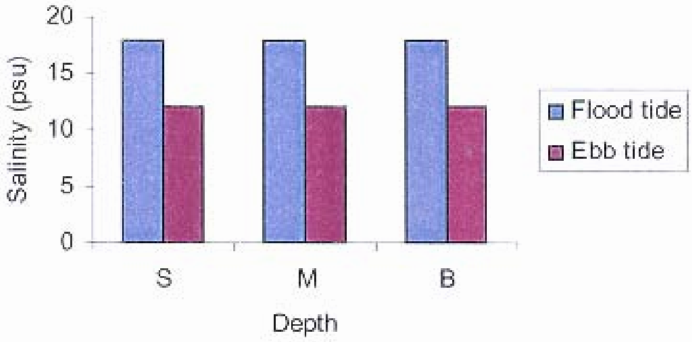

Figure 5d: Concentration of salinity at different depths during flood and ebb tides for Station 4.
S=Surface; M=Middle; B=Bottom

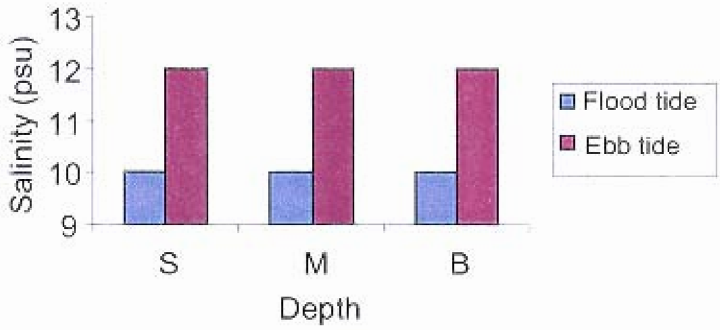

Figure 5e: Concentration of salinity at different depths during flood and ebb tides for Station 5.
S=Surface; M=Middle; B=Bottom

At Station 1, the transparency values ranged from 48.6 cm to 52.5 cm during flood tide and 55.7 cm to 56.3 cm during ebb tide (Table 1 and Figure 6a). At Station 2, the transparency values ranged from 24.8 cm to 29.5 cm during flood tide and 21.5 cm to 22.3 cm during ebb tide (Table 1 and Figure 6b). At Station 3, the transparency values ranged from 37.8 cm to 39.7 cm during flood tide and 25.4 cm to 25.7 cm during ebb tide (Table 1 and Figure 6c). At Station 4, the transparency values ranged from 25.8 cm to 27.8 cm during flood tide and 19.0 cm to 19.4 cm during ebb tide (Table 1 and Figure 6d). At Station 5, the transparency values ranged from 26.5 cm to 26.8 cm during flood tide and 19.6 cm to 19.8 cm during ebb tide (Table 1 and Figure 6e).

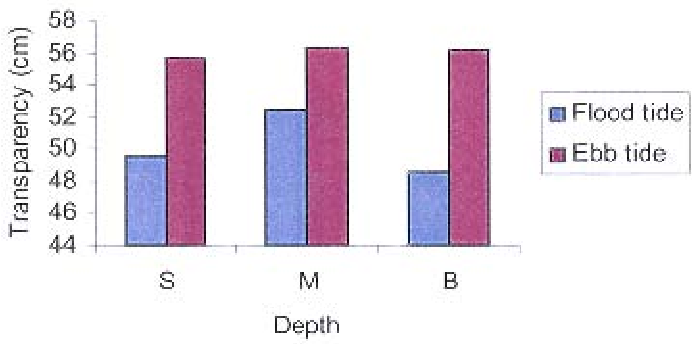

Figure 6a: Values of transparency at different depths during flood and ebb tides for Station 1. S=Surface; M=Middle; B=Bottom

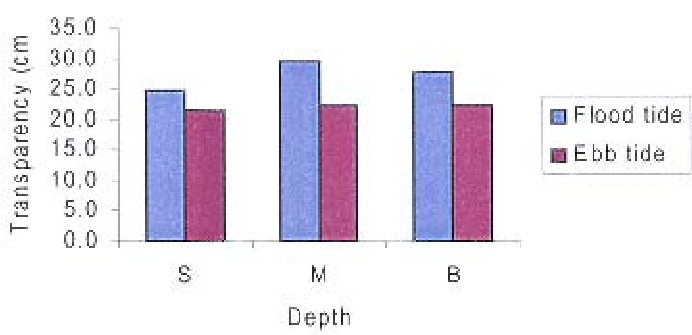

Figure 6b: Values of transparency at different depths during flood and ebb tides for Station 2. S=Surface; M=Middle; B=Bottom