CHAPTER II

METHODOLOGY

The Study Area

The study area was focussed on the water of the Chao Phraya River draining from the upper and central basins covering an area of about 142,000 km^2. The stations were chosen at Amphoe Pak Kret, Nonthaburi Province, between latitude 13^o 55' 12" N and longitude 100^o 30' 03" E and at Anphoe Bang Sai, Ayutthaya Province, between latitude 14^o 11' 25" N and longitude 100^o 30' 18" E (Fig. 1-3). The former is typically contaminated by anthropogenic activities such as industry, sewage and domestic use (Fig. 4). In contrast, the latter received less human influences than the former (Fig. 5). The study sites were chosen for the reason on comparing the concentration and flux of some materials under different environments. This area the tidal current affects the direction of water flow. The sampling designs were performed as follows:

1. Pak Kret Station (Transect A)

The cross section area of transect was divided into three depth levels. There are 0.2, 0.6 and 0.8 of the total depth of the transect. The flow measurement and the collection of water samples were made at three horizontal points and three depth levels in the transect as shown in Fig. 6 (A).

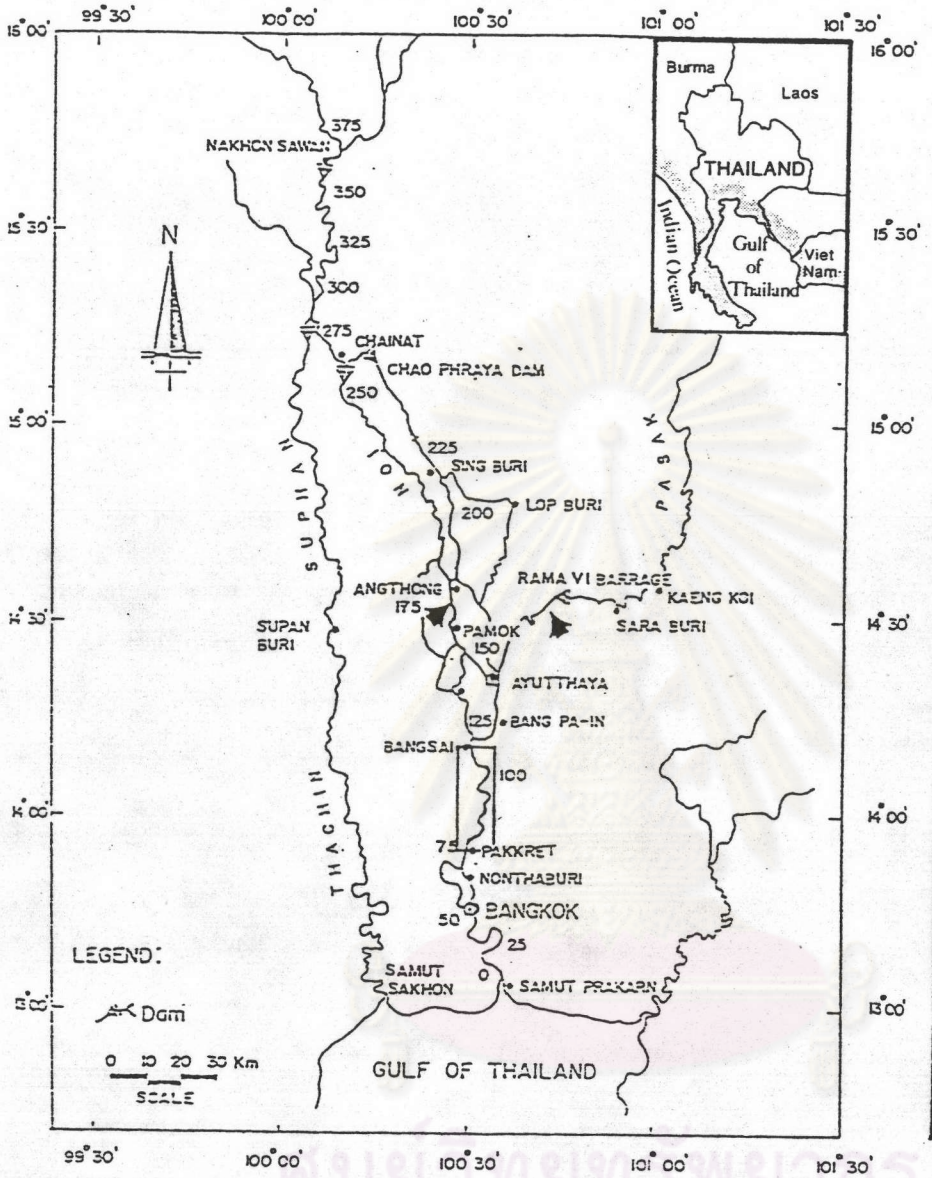

Figure 1 Map of the Lower Chao Phraya System
(Onodera, 1985)

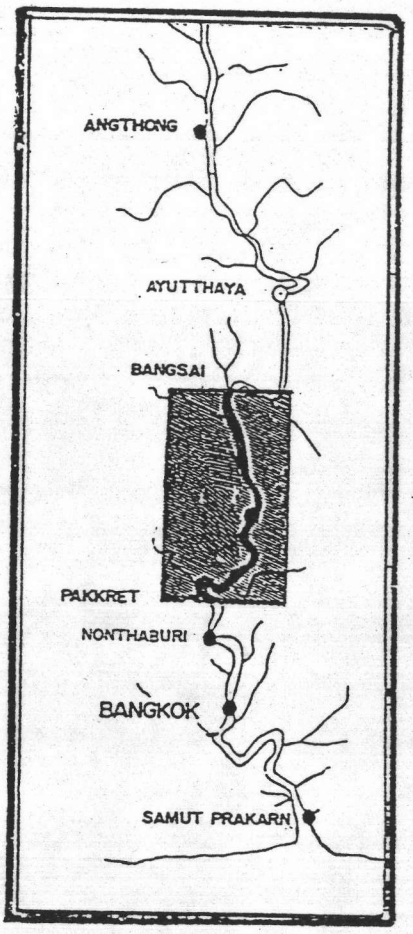

Figure 2 Study Area

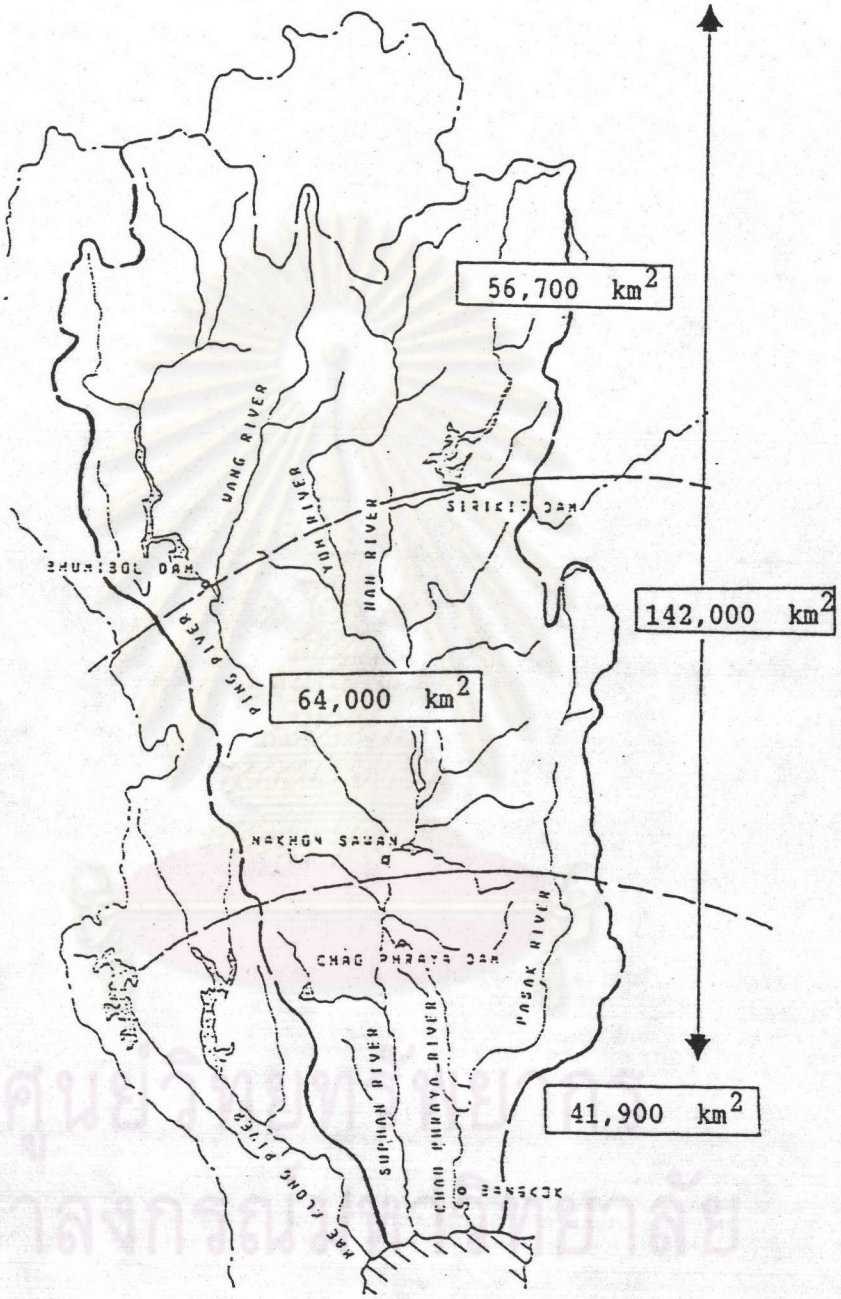

Figure 3 Location Map of the Chao Phraya River Basin

(Included Suphan River Tributaries ; JICA,1989)

หอสมุดกลาง สถาบันวิทยบริการ จุฬาลงกรณ์มหาวิทยาลัย

Figure 4 Environments in the region of Pak Kret Station.

จุฬาลงกรณ์มหาวิทยาลัย

Figure 5 Environments in the region of Bang Sai Station.

Point 1 (A2) at the center of transect,

Point 2 (A1) near storehouse which is on the Bangkok side or the right bank of the river, and

Point 3 (A3) near Wat Tamnaknua which is on the Thon Buri side or the left bank of the river.

Note : The left and right banks of the river are identified by an observer facing upstream.

2. Bang Sai Station (Transect B)

The station is near Pak Khlong Kag. The flow measurement and the collection of water samples were only made at the center of the transect, but the sampling depths are the same as for Transect A. The cross-sectional profile of Transect B is shown in Fig. 7 (A).

3. Sampling Period and Frequency

The flow measurement and the collection of water samples were carried out between December 1987 and December 1988. The sampling were performed during the followings :

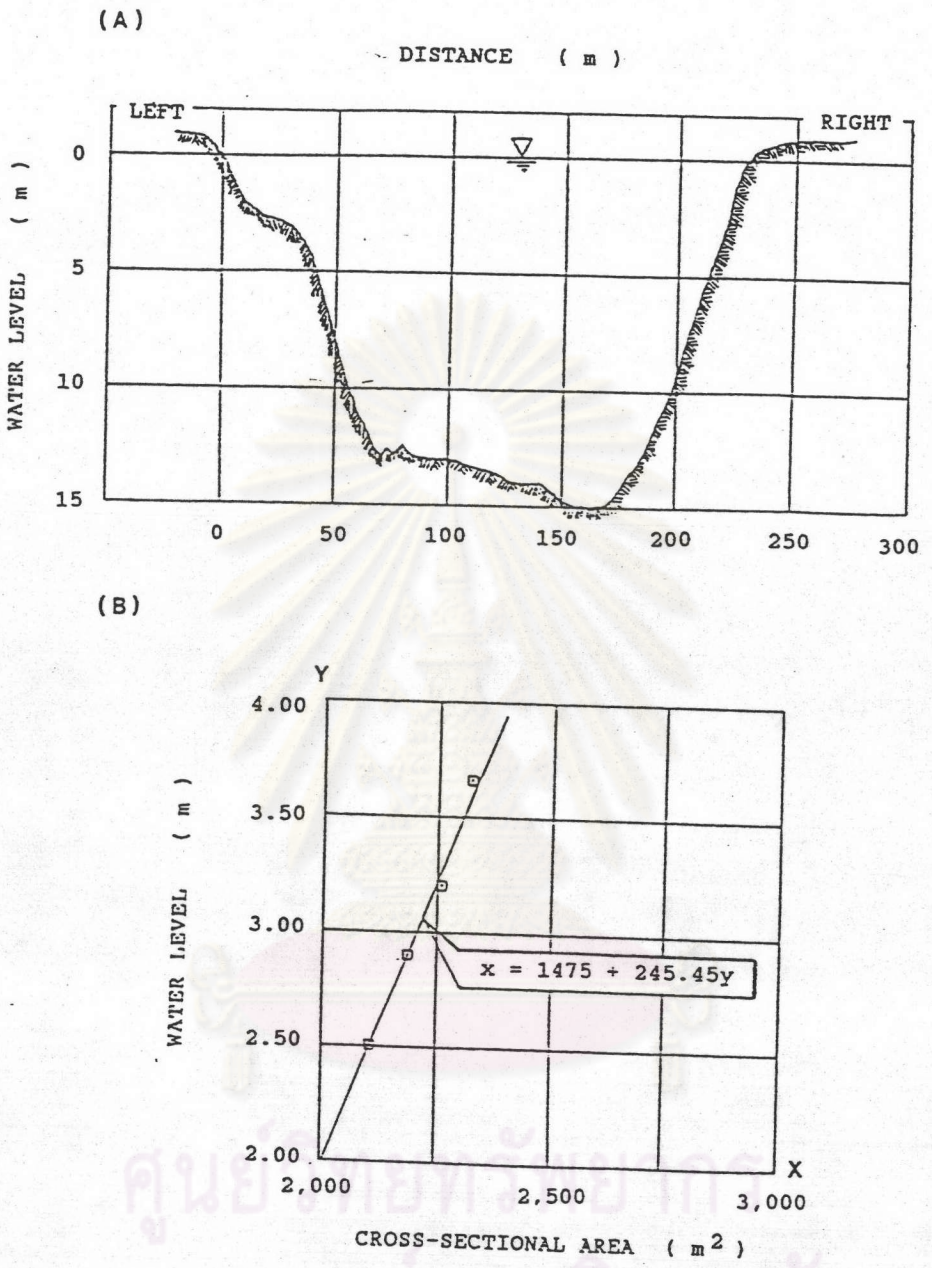

Figure 6 The Cross-sectional profile (A) and the relationship between the water level and cross-sectional area (B) of Pak Kret Transect.

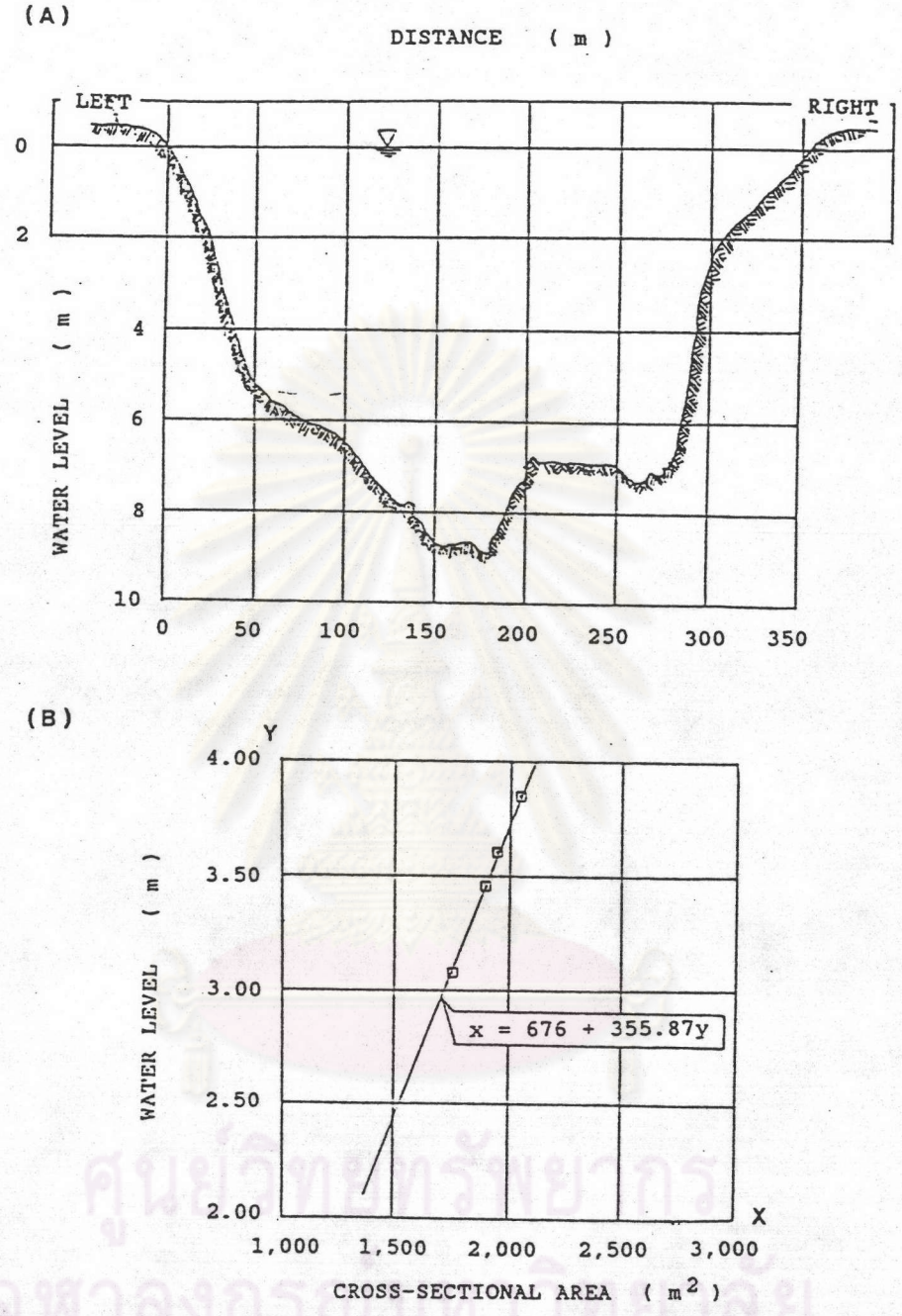

Figure 7 The Cross-sectional profile (A) and the relationship between the water level and cross-sectional area (B) of Bang Sai Transect.

Period	Frequency	Transect
1. December 6, 1987 - January 19, 1988	Fortnightly	A
2. March 13, 1988 - May 6, 1988	Fortnightly	A, B
3. June 1988 - December 1988	Monthly	A

Field Measurement

Hydrological survey was made to record some hydrological parameters and to collect water samples for chemical analysis. The parameters recorded were water level, cross-sectional area, current velocity and direction, salinity and some meteorological data of the study area.

In order to compute the material fluxes, it is necessary that sampling must be carried out at regular interval over a tidal cycle. The estimation is based on simultaneous measurements of longitudinal velocity and collection of water samples for the determination of suspended material and some nutrient concentrations.

The field measurement in this study was supported and provided by the Surveying and Chart Reproduction Division, Hydrology Section, Harbour Department, Bangkok, Thailand.

The special equipments used are :

- Gytre "MINI" Current Meter, model SD-2/SD-2T, direct-reading current volocity and direction
- "RAYTHEON", fathometer or echo depth sounding, model DE-716C
- The Water Level Recorder
- Lead and Line for measuring the water depth
- Winch and Hydrowire
- The Cole Parmer Water Sampler
- The Petersen-type dredge used for bottom sediment collection
- The sextant used for measuring the traverse direction of transect
- The angle plotter
- Hand refractometer or salinometer

The steps of field measurement are in the followings :

- The study area were decided and selected at Pak Kret and Bang Sai Stations.
- Both stations are located by a landmark on the bank to determine the fixed position of the survey boat.
- Pak Kret Station was established at a temporary site of the portable gauge installation. Bang Sai Station has been established at a permanent site of water recorder installation by Port Authority of Thailand.
- The river depths were measured by the echo depth sounder, model DE-719 C and the cross section area of each transects computed.
- The sampling depths or the flow measurement sites were determined every hours over a tidal cycle by using the lead and line method.

- The flow measurement and the collection of water samples were carried out every two hours over a tidal cycle.
- The samples, both water and sediment samples, were kept in a refrigerator until the laboratory analysis.
- The instantaneous cross-sectional discharge of both transects were computed.

1. Method for measuring discharge

In this study the flow measurement were measured hourly over a tidal cycle using Gytre "MINI" Current Meter (model SD-2/SD-2T). With the tide data it could be convert into cross-sectional areas from a calibrated regression curve which was fitted between water levels (y-axis) and corresponding simulated cross-sectional areas (x-axis) of each transect profiles. The models are as follows:

$$x = 1475 + 245.45\ y \quad ..... (1)$$

$$x = 676 + 335.87\ y \quad ..... (2)$$

Equation (1) is the model for Pak Kret Transect (Fig. 6 B)

Equation (2) is the model for Bang Sai Transect (Fig. 7 B)

The regression analysis using these models yield an estimate of the instantaneous cross-sectional areas for both transects.

Finally, the instantaneous cross-sectional discharge, Qi, calculated by multiplying an instantaneous averaged current velocity of three points (A1, A2, A3) or called corrected velocity (Va) with a simulated cross-sectional area of which water passing through the transect. The total discharge was determined by intergrating the instantaneous cross-sectional discharge across the transect.

The relationships between the averaged current velocities at the center of river (Vc) and the corrected velocities (Va) which were observed on January 5, 1988 at Pak Kret Transect is shown in Fig. 8.

2. Method of water sampling

The water samples were taken from surface, middepth and bottom levels once every two hours over a tidal cycle using the Cole Parmer Water Sampler. Then stored in a closed sample bottles and kept in a refrigerator until analysis.

Laboratory analyses

1. Apparatus and Equipment

- The Millipore filtration equipment designed to hold 47-mm diam filter paper
- Whatman GF/C filter papers with pore size 1 µM
- A balance capable of weighing to the nearest 0.1 mg
- Spectrophotometer
- Centrifuge and centrifuge tubes
- Vortex mixer
- pH meter
- Autoclave
- Salinometer
- Automatic pipette
- Refrigerator
- Forceps
- Cleaned laboratory glassware

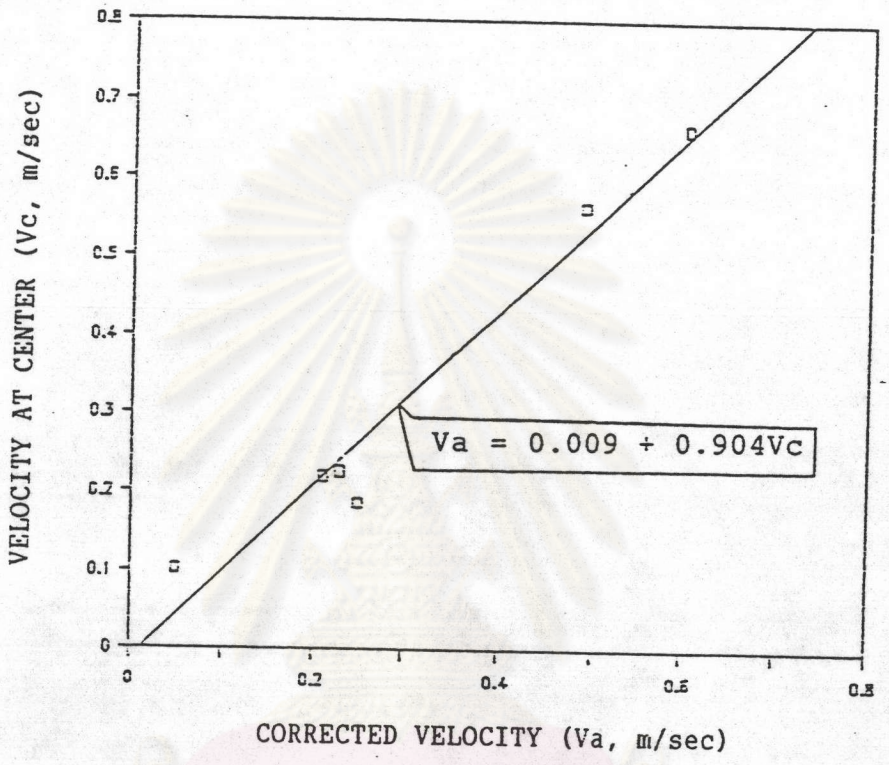

Table 8 The relationship between the corrected velocity (Va) and the velocity measured at the center (Vc) of the river.

- Desiccator
- Parafilm sheet
- Aluminum foil
- Oven

2. Procedure

2.1 Water Sample Analysis

Water samples were collected for chemical analyses of the followings

2.1.1 Determination of reactive dissolved phosphorus (Strickland and Parsons, 1972).

2.1.2 Determination of total dissolved phosphorus by acid persulphate oxidation (Koroleff, 1968).

2.1.3 Determination of reactive dissolved silicate, H_4SiO_4, (Strickland and Parsons, 1972).

2.1.4 Determination of Suspended Sediment

The suspended sediment analysis is obtained as the dry weight of the suspended material retained by a filter dried at 105^{o} C. Results are expressed in milligram per litre (mg/l).

2.2 Sediment Analysis

The collected samples of bottom river sediment must be homogenized and sieved through 1.5-2 mm pore size sieve. Then stored in a closed glass bottles and kept in a refrigerator.

2.2.1 Determination of dissolved particulate phosphorus

The method described here is a modification of Olsen and Dean (1965) as given by Umnuay (1982). The special reagents required are extraction solution (0.5 M HCL : 1 M H_2SO_4) together with reagents for determination of reactive dissolved phosphorus (Strickland and Parsons, 1972). The analysis were carried out as follows:

Remove the GF/C filter paper containing the suspended sediment by rolling or folding the filter paper into a test tube. Pipette 10 ml of extraction solution (0.5 M HCL : 1 M H_2SO_4) into each sample tubes, which closed with stopper, and mix the sample solution with a vortex mixer for 15 minutes until the paper become soft and disintegrate as a homogeneous mixture. Then transfer this mixture into a centrifuge tube which closed with a parafilm sheet and centrifuge at 3,000 rpm for 20 minutes. Remove 1 ml of the supernatant into another test tube with an automatic pipette, then dilute to 10 ml with distilled water and add 1 ml of mixed reagent. Mix, stand for 5 minutes and measure the absorbance with a spectrophotometer at 885 mm wavelength (Strickland and Parsons,1972).

2.2.2 Determination of Available Phosphorus in river sediment

Measure accurately the weight of 0.5 g of wet, seived sediment sample into a flask. Pipette 30 ml of extraction solution (0.5 M HCL : 1 M H_2SO_4) immediately into each sample flasks, closed with stopper, shake for about 30 minutes and let stand at room temperature for two hours. Transfer the shaken mixture into a centrifuge tube which is further treated as the procedure described in

2.2.1.

2.3 Mixing Experiments

2.3.1 The Laboratory Simulation on Conservative and Non-conservative Behavior of Phosphorus

The unfiltered river samples collected from under Krungthon Bridge and the unfiltered seawater samples from Sichang Island are freshly mixed in different ratios, forming the mixing series of salinity 0, 6, 12, 18, 24 and 30 ‰. Then shake for 10 minutes to make the solutions homogeneous and allow to stand at room temperature for 0, 0.5, 1, 2, 4 and 6 hours respectively. After the mixing times were reached, the samples are filtered through the Whatman GF/C filter papers. And then the dissolved phosphorus contents are determined using the method of Strickland and Parsons (1972).

2.3.2 Adsorption Capacities of Phosphorus on the Chao Phraya River Sediments.

- The river water and bottom sediment samples were collected on September 20, 1989 from the station near the Harbour Department which is located on the right bank of the Chao Phraya River.

- The procedures of the determination of adsorption capacities of phosphorus on wet sediment in this study are as follows:

Measure accurately the weight of wet, seived sediment 0.5 g into a flask. Solutions of known pH and

salinity (fresh water or saline water) were mixed with the dissolved phosphorus solution (adsorbate) by adding the different concentrations of adsorbate into a beaker containing of 90-100 ml of solutions. This mixture must have the total volume 100 ml. Immediately transfer this mixture into the flask containing the known weight sediment sample. Shake for 30 minutes and allow them to stand at room temperature for 2-3 hours to make sure that the reaction has reached equilibium. After the time has been reached, the solution is shaken well and the pH is measured again and then about 50 ml of this solution is filtered on a GF/C filter paper. The residual concentration of phosphate in the filtered solution is determined using the method of Strickland and Parsons (1972).

Remove the filtered sediment from the holder with a pair of forceps onto a clean aluminium foil and dry in the oven at 105^{o} C for one hour and then transfer it into a desiccator for cooling to room temperature. The dried sediment is weighed to the nearest 0.1 mg and then extracted to determine the total dissolved phosphorus adsorbed on sediment by using 10 ml of extraction (0.5 M HCL : 1 M H_2SO_4). Then further continue the procedure as described in the determination of particulate phosphorus. The results are computed and plotted to determine the adsorption capacities of the sediment.

Flux Estimation Method

In order to describe riverine processes, typical seasonal and spatial patterns of material transport through river-estuarine system in the Chao Phraya River, a typical climatic zone river, some material fluxes at Pak Kret and Bang Sai Transects were estimated basing on

simultaneous measurements of longitudinal velocity and collection of water samples from which suspended sediment, reactive dissolved phosphorus, total phosphorus, particulate phosphorus and reactive dissolved silicate concentrations were determined.

The procedure of estimating the daily net fluxes in this study is the interpolation method given by GESAMP (1987). It based on (1) estimating the instantaneous material fluxes by multiplying an instantaneous material concentration corresponding to an instantaneous discharge (derived from every two hours measurement) over a tidal cycle and (2) the final derivation of daily net fluxes computed by summing all of the instantaneous flood and ebb material transport (13 figures) obtained from (1).

The method of flux calculation here is shown as follows:

$$\text{Total Load} = K \sum_{i=1}^{n} \left(\frac{CiQi}{n}\right)$$

K = Conversion factor taking into account the period of record

Ci = Instantaneous concentration associated with individual samples

Qi = Instantaneous dischagre at the time of samping

n = Number of samples

The annual mean of material fluxes were estimated by summing the monthly mean of material fluxes during December 1987 to December 1988. The monthly mean material flux was derived by multiplying a monthly mean concentration corresponding to a monthly mean discharge at the time of sampling.

Using these methods, the reliability of flux estimated will depend on how representative the flow-weighted concentration value derived from a relatively small number of water samples is. The methods also differ with respect to the discharge employed in the calculation procedure.

ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย

I10306560.