

32. RESULT OF STUDY

ON

BOTTOM SEDIMENT QUALITY

ผลการวิจัยคุณภาพดินก้นทะเลสาบสงขลา

(ตอนใน)

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34. SUB-PROJECT TEAM

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### 35. Purpose of the project

This research project covered the period of May 1978 - April 1979. The lake survey is carried out the inner lake and the outer lake with 40 samples. The purpose of the report are include :

- 35.1 To study the contents of some heavy metals in the lake sediments
- 35.2 To study the annual regime of nitrogen and phosphorus in the bottom sediment and in interstitial water of various parts of the lake
- 35.3 To evaluated the significants of bottom sediments as source of the lake plants nutrients.
- 35.4 To study the physical properties of bottom sediments in the lake
- 35.5 The baseline data for planning and developing the lake environments.

### 36. Scope

The Characterization of the Lake Bottom Sediment is carried out the inner lake and the outer lake. A parameter which interesting are followed.

- 36.1 Interstitial water : to determined  $\text{N-NO}_3^-$ ,  $\text{N-NH}_4^+$ ,  $\text{P-P}_4^{3-}$
- 36.2 Physical properties : to determined water contents and a Soil texture
- 36.3 Chemical properties : to determined Org-C, Total-N, Total-P Heavy metal such as Cd, Cu, Fe, Mn, Pb, Zn.
- 36.4 To comparison of each parameter by region and station
- 36.5 To study ratio of nutrient elements such as Org-C/N, Org-C/P and N/P

## 37. Methodology

### 37.1 Apparatus.

Analytical balance

Atomic Absorption Spectrophotometer

Blender with dispersion cup

Core sampler

Dissicator

Glassware

Hot plate

Hydrometer

Macro - Kjeldahl digestion apparatus

Macro - Kjeldahl distillation apparatus

Magnetic bar

Magnetic stirrer

Oven

pH - meter : model PBL, Sargent - Welch Scientific Company.

Refrigerator

Spectrophotometer : model CE 202 ultraviolet Grating Grating

Spectro-photometer Cecil instruments limited.

: Hach dr/2 Spectrophotometer, Hach Chemical  
Company.

Teflon cup

Thermometer

vacuum pump

### 37.2 Chemical Reagents.

Boric acid, AR. grade, Mw. 61.83, assay 99.5 % min., Ajex chemical Ltd.

Sydney.

- Hydrochloric acid., Mw.36.46, assay 36 % w/w, wt/ml 1.18 g., Hopkin & William, England.
- Hydrofluoric acid., AR grade, Mw.20.01, assay 40 % w/w, Ajax chemical Ltd., Sydney.
- Nitric acid, Mw 63.01, Ar grade, assay wt/ml 1/42 g, Hopkin & William, England.
- Perchloric acid,
- Sulfuric acid, Mw 98.08 assay 98 %, wt/ml 1.84 g. Hopkin & William, England
- Sodium hydroxide, Mw 40 Lab grade, assay 96 %, BDH chemical Ltd, England
- Amminium metavanadate, Mw 1235.86, assay 99 %, Riedel-Dehaenag Seelze-Hannover, Germany
- Ammonium molybdate,
- Chloroform, wt/ml 1.471 g;AR grade, Ajax chemical Ltd, Sydney
- Copper sulfate, Mw 249.69, Lab grade, assay 98.5 %, May & Baker Ltd, England
- Ethenol, Mw 46.07, AR grade, assay 99.5 %, Ajax chemical Ltd, Sydney.
- Ferrous sulfate, Mw 278.02, AR grade, Mallinckrodt, USA.
- Hydrogen peroxide, MW, assay w/v H<sub>2</sub>O 30 %, wt/ml 20°C 1.10 g., BDH chemical Ltd, England
- Nessler's reagent, Hach chemical company, USA
- Nitra Ver 4 reagent, Hach chemical company, USA
- Potassium dichromate, Mw 294.19, AR grade, assay 99.9 %, Ajax chemical Ltd, Sydney.
- Potassium dihydrogen phosphate,
- Potassium sulfate, Mw 174.27, assay 99 %, May & Baker Ltd, England.
- Phos Ver II Powder Pillow, Hach chemical company, USA.
- Sidoum hexametaphosphate, BDH chemical Ltd, England.

Zinc glanula, Mw 65.37, E.Merck, Germany.

Bromocresol green, May & Baker Ltd, England.

Methyl red, May & Baker Ltd, England.

1-10 phenanthroline, Mw 198.23, Riedel-Dehaen Seele-Hannover, Germany

### 37.3 Method and Frequency to collect the sample

The top 0-5 cm. of Sediments with interstitial water are collect 2 times per year in August 1978, January 1979, with the Core sampler. Three sample are taken for replication of a station.

The pH is determined immediatly, then the sediment is devided into two portions. A portion of the sediment for analysis of interstitial nitrat nitregen interstitial ammonia nitrogen, and intersitial phosphate phosphorus, is steriled by chloroform about 40 cc. per 800 - 1,000 gm. of sample and transfer of polyethylene bags. Stored at approximatly 4°C until analysis

Another portion of sediment is transfer to polyethylene bags and stored at approximatly 4°C until it is taken to Laboratory, their portion sediment is dried in oven of 105°C overnight. The dried sediment is ground until they pass trough a 0.5 mm . aperture screen. The dried powder is returned to the oven an addition hour. After cooling in dissicator, it is transfered to vial and stored until analysis.

### 37.4 Procedure

37.4.1  $\text{N-NH}_4^+$  : Determined by Hach dr/2 Spectrophotometer.

#### Reagent.

Nessler's reagent

#### Procedure

1. Take a water sample by filling a clean 25-ml graduated cylinder to the 25-ml mark. Pour into a clean sample cell.



2. Measure 25 ml. of demineralized water by filling another clean 25 ml. graduated cylinder to 25 ml. mark. Pour the demineralized water into another clean sample cell.

3. Using the 1 ml calibrated dropper, add 1 ml of Nessler's reagent to each sample cell and swirl to mix. A yellow color will develop if ammonium nitrogen is present. Allow at least 10 minutes, but not more than 25 minutes for the color to fully develop and then proceed with Step 4

4. Place the sample cell containing the prepared demineralized water solution in the cell holder. Insert the Ammonium Nitrogen (Nessler's method) Meter Scale in the meter and adjust the wavelength dial to 425 nm. Adjust the Light Control for a meter reading of zero mg/l

5. Place the prepared sample in the cell holder and read the mg/l ammonium nitrogen.

#### 37.4.2 $\text{N-NO}_3^-$ ; Determined by Hach dr/2 Spectrophotometer.

##### Reagent.

Nitra Ver V Nitrate Powder Pillow

##### Procedure.

1. Take a water sample by filling a clean 25-ml cylinder to the 25 ml mark. Pour the sample in to a clean sample cell.

2. Add the contents of one Nitra Ver V Nitrate Reagent Powder Pillow to the sample cell, stopper, and shake vigorously for exactly one minute. An amber color will develop if nitrate nitrogen is present. To allow time for proper color development, wait at least 6 minutes but not more than 15 minutes before completing Step 3 and 4

3. Fill another sample cell with about 25 ml of the original water sample and place it in the cell holder. Insert the Nitrogen Nitrate (Nitra Ver V method) Meter Scale in the meter and adjust the wavelength dial to 500 nm. Adjust the Light Control for a meter reading of zero mg/l

4. Place the prepared sample sample in the cell holder and read the mg/l nitrate nitrogen

37.4.3  $\text{P-PO}_4^{-3}$  : Determined by Hach dr/2 Spectrophotometer.

Reagent.

Phos Ver III Powder Pillow

Procedure.

1. Take a water sample by filling a clean 25-ml graduated cylinder to the 25-ml mark. Pour into a clean sample cell.
2. Add the contents of one Phos Ver III Powder Pillow and swirl to mix. A blue-violet color will develop if phosphate is present. Allow 2 minutes for the color to fully develop and then proceed with Step 3
3. Fill another sample cell with about 25 ml the original water sample and place it in the cell holder. Insert the Phosphate (Phos Ver III method) Meter Scale in the meter and adjust the wavelength dial to 700 nm. Adjust Light Control for a meterreading of zero mg/l.
4. Place the prepared sample in the cell holder and read the mg/l phosphate

37.4.4 pH : determined by glass electrode (ph-meter)

The determination of the hydrogen ion activity or pH of soil is by far the most commonly made soil test. It is widely used by soil testing laboratory and county agents for estimating the lime needs of soil

Sorensen (1909) defines pH as the negative logarithm of the hydrogen ion concentration. Inasmuch as hydrogen ion concentration is actually measured by potentiometric method. The pH is more correctly defined by the following equation :

$$\text{pH} = -\log a_{\text{H}^+} = -\log C_{\text{H}^+} \cdot f_{\text{H}^+}$$

Reagents.

Buffer solution pH 4, 7.

Procedure.

Standardized the meter by immersing the electrode into a standard buffer solution and setting the indicator needle to the pH of the buffer. Then rinse the electrode thoroughly with distilled water and check the instrument with a second buffer solution and rinse the electrode again with distilled water. In subsequent measurement of sample.

37.4.5 Organic Carbon : determined by Walkley Black method.

oxidizable matter in a sample is oxidized by  $\text{Cr}_2\text{O}_7^{2-}$ , and the reaction is facilitated by the heat generated when 2 volumes of  $\text{H}_2\text{SO}_4$  are mixed with 1 volume of 1 N  $\text{K}_2\text{Cr}_2\text{O}_7$  solution. The excess  $\text{Cr}_2\text{O}_7^{2-}$  is determined by titration with standard  $\text{FeSO}_4$  solution and the quantity of substances oxidized is calculated from the amount of  $\text{Cr}_2\text{O}_7^{2-}$  reduced.

Reagents.

Ferrous sulfate ( $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ ) solution, 0.5 N. : Dissolved 69.5 g. of AR grade  $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$  in water, add 15 ml of Conc.  $\text{H}_2\text{SO}_4$ , cool the solution, and dilute it to a volume of 1,000 ml. Standardize this reagent daily titration with standard  $\text{K}_2\text{Cr}_2\text{O}_7$  solution.

Potassium dichromate ( $\text{K}_2\text{Cr}_2\text{O}_7$ ) 1 N : Dissolved 49.09 g. of AR grade  $\text{K}_2\text{Cr}_2\text{O}_7$  (dried at 105°C) in water and diluted the solution to a volume of 1,000 ml.

1 - 10 phenanthroline - ferrous complex (Feroin), 0.025 N ; Dissolved 14.85 g. 1 - 10 phenanthroline monohydrate and 6.95 g of  $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$  in water and dilute dilute the solution to a volume of 1,000 ml.

Procedure.

Grind the sample to pass 0.5 mm sieve avoiding iron or steel mortar. Transfers a weighted sample in to a 500 ml Erlenmyer flask. Add 10.0 ml of 1 N  $\text{K}_2\text{Cr}_2\text{O}_7$ , and swirl the flask gently to disperse the sample in the solution

Then rapidly add 20.0 ml. of Conc.  $H_2SO_4$ , immediately swirl the flask gently until sample and reagents are mixed, then more vigorously for a total of 1 minute. Allow the flask to stand on a sheet of asbestos for about 30 minutes. Then add 200 ml. of water to the flask. Add 3 - 4 drops of Ferroin, and titrate the sample solution with standard  $FeSO_4$  solution. At the endpoint, the color changes sharply from blue to red.

Calculate the results according to the following formula, using a correction factor  $f = 1.33$

$$\text{Org-C \%} = \frac{(\text{meq. } Cr_2O_7^{2-} - \text{meq. } FeSO_4) \times 0.003 \times 100 \times f}{\text{grams water - free sample}}$$

#### 37.4.6 Total Nitrogen determined by Kjeldahl nitrogen method

The Kjeldahl method, the N in the sample is converted to ammonium ( $NH_4^+$ ) by digestion with concentrated  $H_2SO_4$  and the ammonium is determined from the amount of  $NH_3$  liberated by distillation of the digest with alkali.

#### Reagents.

Boric acid-indicator solution ; Place 80 g. of pure  $H_3BO_3$  in a liter flask marked to indicate a volume of 4 liters, add about 3,800 ml. of water and heat and swirl the flask until the  $H_3BO_3$  is dissolved. Cool the solution and add 80 ml. of mixed indicator solution prepared by dissolving 0.099 g. of Bromocresol green and 0.066 g. of Methyl red in 100 ml. of Ethanol. Then add 0.1 N NaOH cautiously until the solution assumes a reddish purple and make the solution to 4 liter by addition of water

Copper sulfate ( $CuSO_4 \cdot 5H_2O$ )

Mercuric oxide red ( $HgO$ )

Potassium sulfate ( $K_2SO_4$ )

Sodium hydroxide (NaOH) Approx 10 N : Place 4.2 Kg, of NaOH in 10-liter Pyrex flask, add 4 liter of water and swirl the flask until the alkaline is dissolved. Cool the solution, make the solution to 10 liter by addition of  $CO_2$ -free water.

Standard sulfuric acid.

Sulfuric acid ( $H_2SO_4$ ) Conc.

Procedure.

Place a sample containing about 10 mg. of N in a dry macro-Kjeldahl flask, add 20.0 ml. of water ; and, after swirling the flask for a few minutes, allow it to stand for a further 30 minutes. Then add 10 g. of  $K_2SO_4$ , 1 g. of  $CuSO_4$ , 2 g. of HgO and 30.0 ml. of Conc  $H_2SO_4$  and heat the flask cautiously on the digestion stand, when the water has been removed and frothing has ceased, increase the heat until the digest clear, and there after boiling the mixture gently for 5 hours, After completion of digestion, allow the flask to cool, and add about 100 ml. of water. Then cool the flask under a cold water tap, and transfer the C contents to 800 ml. Kjeldahl flask for distillation. Four washing of the sandy residue with 50 ml. of water to determine the ammonium-N liberated by distillation Place a 500 ml. Erlenmyer flask containing 50 ml. of  $H_3BO_3$  indicator solution under the condenser of the distillation apparatus so that the end of the condenser is below the surface of the  $H_3BO_3$ , then pour about 150 ml. of 10 N NaOH to distillation flask. Attach the flask as quickly as possible to the distillation apparatus. When about 150 ml. of distillate have been collected, remove the Erlenmyer flask and stop distillation,

Determine ammonium-N in the distillate by titration with standard

37.4.7 Total Phosphorus : determined by vanadomolybdophosphoric yellow color method.

Most soil P determinations have two distinct phases. First, the preparation of a solution containing the soil P, and second, the quantitative determination of the P in this solution. The choice of a colorimetric method for determination P depends on the concentration of P in the solution, the concentration of interfering substance in the solution to be analyzed.

The two most widely used method for extracting the total P from soils are digestion with  $\text{HClO}_4$  and fusion with  $\text{Na}_2\text{CO}_3$ . The recommended procedure involves  $\text{HClO}_4$  digestion of soil followed by a colorimetric determination of the P in the digest. The digestion procedure is preferred because of its simplicity and adaptability as a routine procedure.

The determination of total P by vanadomolybdophosphoric yellow color method in Mitric acid system, the exact nature of the yellow chromogen of the vanadomolybdophosphoric system is not know, but the color is attributed to substitution of oxyvanadium and oxymolybdenum radicals for the Oxygen of  $\text{PO}_4$  to give a heteropoly compound that is chromogenic. The advantages of the method are extreme simplicity stability of color, freedom from interferences with a wide range of ionic species in concentration up to 1,000 ppm.

#### Reagents.

Nitric acid - Vanadate - Molybdate reagent : solution A is prepared by dissolving of 25 g. of ammonium molybdate in 400 ml. of water. Then solution B is prepared by dissolving 1.25 g. of ammonium metavanadate in 300 ml. of boiling water. Solution is cooled and then 250 ml. of Conc.  $\text{HNO}_3$  is added and the solution is again cooled to room temperature. Finally solution A is poure into solution B and the mixture is dilute to 1,000 ml.

Stock Standard 100 ppm. P solution ; dissolve 0.4393 g. of  $\text{KH}_2\text{PO}_4$  in distilled water, dilute the solution to 1,000 ml. with distilled water

Perchloric acid ( $\text{HClO}_4$ ) 50 %

Procedure.

Mixed 2.0 g. of finely sample with 30.0 ml. of 60 %  $\text{HClO}_4$  in a 250 ml. volumetric or Erlenmyer flask. Digest the mixture at a temperature a few degree below the boiling point on a hot plate in a hood until the dark color due to organic matter disappears. Then continue heating at the boiling temperature to the sides of the flask. Occasionally shake the flask ; cool the mixture, add distilled water to obtain a volume of 250 ml., and mix the contents. Allow time for the solid material to settle before before taking an aliquot.

Pipette an aliquot ( 25 ml.) of the solution into a 50-ml. volumetric flask, 10.0 ml. of nitric-vanadate-molybdate reagent is added, and the solution is dilute to 50 ml. with distilled water and mixed well. The color develops rapidly but usually read after 10 minutes to assure full strength. The color is read in the spectrophotometer with a light maximum at 470 nm.

37.4.8 Heavy metals : determined by Atomic Absorption Spectrophotometer.

The sample solution is aspirated into a flame, the element must be converted to the atomic vapour state, most of the atoms in a flame remain in the ground state and it is these ground state atome that are measured in atomic absorption. As the name implies, this is accomplished by measuring the amount of radiation from the source that is absorbed by the atome.

The absorption follows Beer's law, that is the absorbance is directly proportional to the path in the flame and to the concentration of atomic vapor in the flame. The path length can be held constant and the concentration of atomic vapor is directly proportional to the concentration of the analyte in

the solution being aspirated. The procedure used is to prepare a calibration curve of concentration in the solution versus absorbance.

Reagent.

Hydrofluoric acid

Perchloric acid.

Hydrochloric acid (1 + 1)

Procedure.

Digestion the sample with HF + HClO<sub>4</sub> (1 : 1), ratio of sample per acid is 1 : 10 in Teflon cup at 250°C until sample is dried. Add the acid in again in ratio 1 : 5 and heated at 250°C until sample is dried. Cool the sample and add HCl + H<sub>2</sub>O (1 + 1) in ratio 1 : 5 then heated again until sample is clear, cool the sample and dilute with demineralized water to the mark volume

Determined the element with Atomic Absorption Spectrophotometer.



38. Results and DiscussionInterstitial water

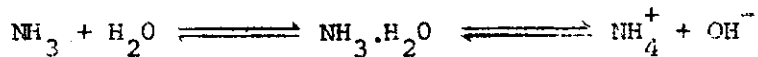
The range and average concentration of  $\text{N-NO}_3^-$ ,  $\text{N-NH}_4^+$  and  $\text{P-PO}_4^{3-}$  in the interstitial water of the Lake Bottom Sediments (August 1978) are presented in Table 32 and Table 40

$\text{N-NO}_3^-$  ; The average concentration of nitrate for the whole lake = as well as for The Region 3 and greather than Region 1 But less than Region 2 (Fig. 306), the maximum value of nitrate is 15.84 ppm. at station 13 and a minimum is 0.90 ppm. at station 11. At station 13, 19, 22 and 39 in Region 2, the value is higher than the criteria value for water supple (Health) of U.S.E.P.A. (10 ppm)

Nitrate is one of five forms of nongaseous, combined nitrogen (amine and amide groups, ammonium, nitrite and nitrate) are important in the nitrogen cycle. The nitrate ion is formed by the complete oxidation of ammonium ions by soil or water microorganisms, nitrite is an intermediats product of this nitrification process. In oxygenated natural water systems nitrite is rapidly oxidized to nitrate. Growing plants assimilate nitrate or ammonium ions and convert them to protein. The major point sources of nitrogen entry into water bodies are municipal and industrial wastewaters, septic tanks, and feedlot discharge. Diffuse sources of nitrogen include farm-site fertilizer and animal wastes, lawn fertilizer leadeate from waste disposal in dumps or sanitary land fills, atmospheric fallort and losses from natural sources such as mineralization of soil organic matter.

$\text{N-NH}_4^+$  : The value are difference by each region, the outer lake is greather than the inner lake (Fig. 306). The maximum value is 4.0 ppm. at station 4 and minimum is 0.15 ppm. at station 6 and 10.

Ammonium ions were produced from ammonia ion to reacts with water. The equilibrium for this chemical species can be expressed in simplified form by the equation.



The toxicity of aqueous solutions of ammonia is attributed to the  $\text{NH}_3$  species. Because of the equilibrium relationship among  $\text{NH}_3$ ,  $\text{NH}_4^+$  and  $\text{OH}^-$  The toxicity of ammonia is very much dependent upon pH as well as the concentration of total ammonia. Wuhrmann, et al (1947) so concluded that  $\text{NH}_3$  fraction was toxic to fish and that the  $\text{NH}_4^+$  fraction had little or no toxicity.

In most natural water, the pH range is such that the  $\text{NH}_4^+$  fraction of ammonia predominates, However, in highly alkalinity water.

P-PO<sub>4</sub><sup>3-</sup> : The average concentration of phosphate for the whole lake as well as for all sub-region. The maximum value is 0.74 ppm. at station 13 and minimum is 0.03 ppm. at station 33

Total phosphate phosphorus concentration in excess of 100 ug/l P. may interfere with coagulation in water treatment plants, when such concentration exceed 25 ug/l at the time of the spring turnover on a volume - weighted basis in lake, they may occasionally stimulated excessive or nuisance growths of algae and other aquatic plants. Algal growths impart undesirable tastes and odors to water, interfere with water treatment, become aesthetically unpleasant, and alter the chemistry of the water supply. They contribute to the phenomenon of cultural eutrophication.

Phosphate and nitrate are key limiting nutrient in oligo trophic lakes and that their introduction will often initiate eutrophication. Most Phosphate which enters water courses from human and agriculture sewage and industrial effluent. The leashing of phosphate fertilizer is probably insignificant in most areas although surface run-off, after sudden and high rainfall, may transport phosphates to water courses. As little as 0.01 ppm. phosphorus will initiate eutrophication if other nutrients are in excess. However, as "background" soluble phosphate level are often in excess of this (0.5 ppm.), nitrogen is probably the major factor, at least in the early stages of eutrophication (N:P = 15:1)

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## 38. Results and Discussion

### Interstitial water

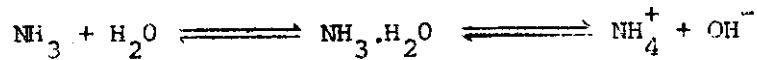
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## Lake Bottom Sediment

### Physical properties

Range and average percentage of water contents and a soil texture of the Lake Bottom Sediments are showed in Table 54 and Table 57

Water Content : The average percentage of water contents for the whole lake as well as for all sub-region. The maximum value is 19.64 % at Station 4 and minimum is 37.79 % at Station 38 (Figure 132)

A Soil Texture : A comparison of sand, silt, clay by region are showed in Fig. 133 Silt is a major predominant. A percentage of clay for the whole lake as well as for sub-region and the minimum value of clay is 0 at station 20, 25 and the maximum value is 25 % at station 6.

### Chemical properties

Range and average of pH is showed in Table 32 to 49 Average pH of the Whole Lake as well as for all sub-region. The maximum value is 8 at station 2 and minimum is 5.5 at station 17 (Fig. 287) All station, pH is near 7 except station 2 and 17. So that, pH of Bottom Sediment in various part is neutral, because of for practical purpose soils between pH 6.6 - 7.3 are considered neutral.

The effect of soil pH are biological. Some organisms have rather small tolerance to variation in pH. Perhaps the greatest general influence of pH on plant growth is the effect of pH on the availability of nutrient.

### Nutrient elements

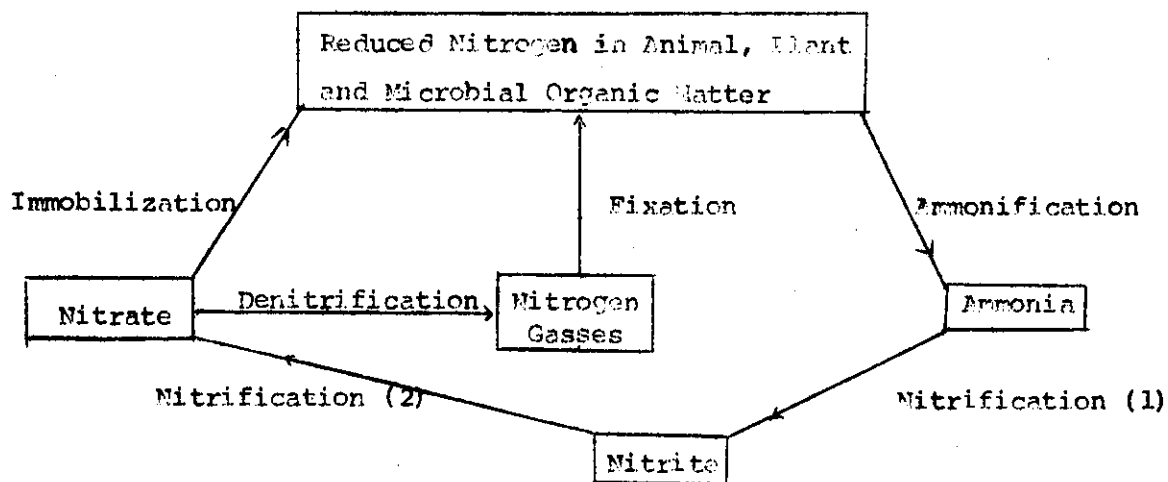
Range and average concentration of Org-C, total nitrogen, total phosphorus in the Lake Bottom Sediments (August 78 and January 79) are showed in Table 32 to Table 49

Org-C : The average percentage of Org-C for the Whole Lake and sub-region in January's sample is more than in August's sample except region 3 (Fig. 135) The maximum value of Org-C is 2.29 % at station 32 and minimum is 0.48 % at station 17 for August's sample Table 33 while the maximum for January's sample is 3.0 % and minimum is 0.56 % at station 10, 20 respectively.

Org-C is one in many parts of organic matter in Sediment. As the rock and mineral of the earth's crust decomposed, mineral element were made available to plant. As the supply of available plant nutrients in the soil increased, the accumulation of soil organic matter increased accordingly This conditions continued until an equilibrium was reached at which the rate of organic matter accumulation was equal to the rate of decompose. A factors that influence the amount of organic matter in soil including climate, vegetation drainage cultivation, soil texture etc.

Total Nitrogen : The average of total-N for the Whole Lake and all sub-region is increased except Region 3, as same as Org-C The maximum value of total-N is 784.0 ppm. and minimum is 266.0 ppm. at Station 38, 3 respectively for August's sample, While January's sample, maximum value is 875.0 ppm. and minimum is 154.0 ppm. at station 23 and 31 respectively. (Fig. 136)

Nitrogen, as a key component of nucleic acid and proteins, is an element essential to all living things. It is, however, in many instances, available only at sub-optimal levels. By availability we mean the nitrogen which at any one time is in a form that is readily absorbed by the plant roots. (usually as nitrate). The overall levels of nitrogen in the biosphere are well in excess of plant and animal requirements. It is useful at this stage to outline the major microbiological and biochemical mechanisms by which an unavailable form of nitrogen may be transformed to an available one during the course of the nitrogen cycle

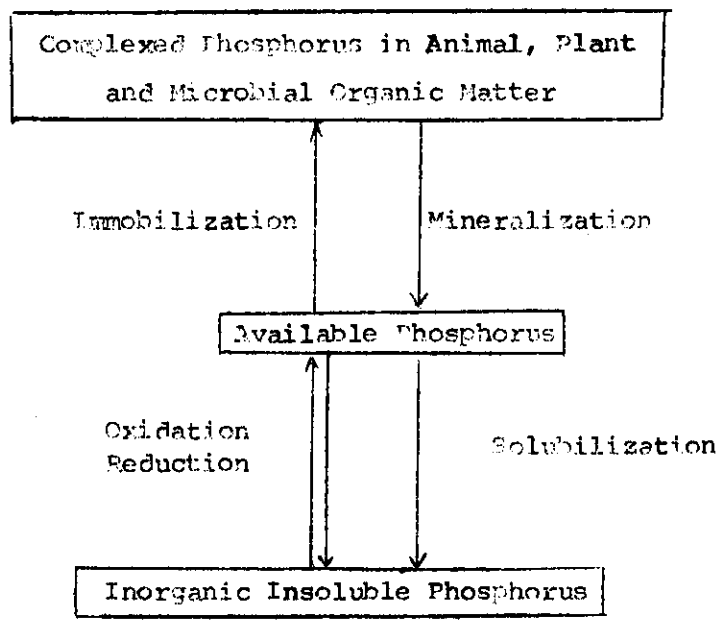


The supply of nitrogen to higher plants is almost entirely controlled by terrestrial and aquatic microorganisms. There are five distinct but inter-related components of the nitrogen cycle ammonification or mineralization, nitrification, immobilization fixation and denitrification,

Total Phosphorus : The average of total phosphorus for the Whole Lake and Inner Lake are increased (Fig. 137) the maximum value of respectively for August's sample. While January's sample, maximum value is 374.08 ppm. and minimum is 50.55 ppm. at station 3.25 respectively.

Phosphorus is a component of nucleic acids, phospholipids, inositol phosphates, sugar phosphates, coenzymes, etc. Plant residues may contain up to 0.5 % phosphorus and, in toto, phosphorus of organic origin (plants, microbes, animals) contributes up to 70 % of that element in soil. Plants are, for the most part, unable to take up organic phosphorus and only utilize it in an inorganic soluble form such as orthophosphate ( $H_2PO_4^-$ )

Whilst there is potentially plenty of phosphorus in soils, much of it exists as insoluble inorganic complexes with iron, magnesium and aluminium, especially at acid pH. As a result, even soils with high phosphorus levels may support crops with a deficiency of phosphorus



Unlike nitrogen, phosphorus does not undergo any valency changes during assimilation and enters into organic combinations as phosphate. Nor is it likely that changes occur during organic matter degradation. This lack of volatility and reactivity of phosphorus produces a somewhat limited and less spectacular biological cycle than that of nitrogen. The involvement of soil micro organisms in phosphorus transformations may include : (a) changing the solubility of inorganic phosphorus, (b) mineralizing organic material to release orthophosphate, (c) converting available phosphorus to microbial protoplasm (immobilization), and (d) oxidation and reduction reactions.



The ratios of Org-C/N, Org-C/P and N/P

Range and average ratio of Org-C/N, Org-C/P and N/P for the Lake Bottom Sediments (August 78 and January 79) are shown in Table 33.

Org-C/N : The annual average of Org-C/N for the whole Lake and all sub-region are increased while the outer lake is constant because of the value of the Inner Lake is increased. The Inner Lake which divided to Region 2, 3 Region 3 is increased but Region 2 is constant. (Table 33) The maximum value is 45.38 and minimum is 10.55 at station 3, 39, for August's sample, respectively while the maximum value is 54.79 and minimum is 11.09 at station 17, 31, respectively for January's sample (Fig. 138).

Org-C/P : The annual average for the whole Lake is increased, as well as for all sub-region for August's sample. and the maximum value is 226.38 minimum is 29.07 at station 33 and 5 respectively (Fig 296), while the January's sample, the maximum value is 463.58 and minimum is 19.05 at station 10 and 19 respectively. (Fig. 138)

N/P : The annual average for the whole Lake and sub-region are increased, except region 3 (Table 33). The maximum value is 9.19 and minimum is 0.97 at station 30 and 3 respectively for August's sample while January's sample, the maximum value is 13.85 and minimum is 1.40 at station 24 and 3 respectively (Fig. 138).

## Heavy metals

The result in ppm per dried weight of the Bottom Sediment by Region (August 78) are showned in Table 34 and Table 49. Enrichment of heavy metals in the Bottom Sediment of the Outer Lake is greather than the Inner Lake while Cd. and Cu is equal (approximately). see Fig. 139.

Cd. : The maximum value is 16.10 ppm. and minimum is 1.90 ppm. at station 2 and 9 respectively.

Cu. : The maximum value is 260.20 ppm. and minimum is 130.60 ppm. at station 4 and 2 respectively.

Ee. : The maximum value is 48,510 ppm. and minimum is 16.000 ppm. at station 32 and 33 respectively.

Mn. : The maximum value is 733.50 ppm. and minimum is 199,80 ppm. at station 6 and 38 respectively.

Pb. : The maximum value is 78.50 ppm. and minimum is 31.50 ppm. at station 6 and 33 respectively.

Zn. : The maximum value is 88.60 ppm. and minimum is 29.00 ppm. at station 4 and 38 respectively.

Using the "Clay universal standard" for comparison, because of no reference background data exist for Lake Songkla. The following data are in mg/kg.

Location	Cd	Cu	Fe	Mn	Pb	Zn	N	P
Lake Songkla	9	195	28912	364	53	53	471	144
Laguna de Bay	-	115	51000	1600	37	446	2100	120
Meralco	-	94	29000	-	21	98	1250	330
San Pedro	-	130	47000	1100	41	421	-	40
San Cristobal	-	118	37000	-	70	121	-	14
San Juan	-	86	31000	-	17	118	-	51
Santa Cruz	-	59	30000	-	23	115	-	61
Clay Standard	-	45	-	850	20	95	-	-

The finding can be summarize as follows ;

1. The Cu content in the Lake Sediment of 195 mg/kg is 4.3 times higher than the clay standard

2. The Pb content in the Lake Sediment of 53 mg/kg is 2.6 times higher than the clay standard

3. The Mn, Zn content in the Lake Sediment of 364, 53 mg/kg is 1.8, 2.1 times lower than the clay standard

4. The element Pb, Cu are in all significantly higher than the clay standard.

The following table shows background data for toxic trace element in sediment cores of 6 major lakes in mg/kg :

	Lake Constance	Lake Michigan	Lake Monoa	Lake Washington	Lake Eric	Laguna de Bay	Lake Songkla
Pb	19	40	14	20	-	37	53
Cu	30	44	22	15	18	115	195
Zn	124	129	15	60	7	446	53

The data show a wide variation of the concentrations between these lakes. In comparison (last column), the Zn concentration in the Sediment of Lake Songkla fall in the middle range of these lakes. However, the concentration of Pb and Cu in the Sediment of Lake Songkla is 1.4 and 1.7 times higher than the values found for the Lagunade Bay.

### 39. Summary and conclusions

Characterization of the lake songkla bottom sediments project, to study about physical property such as water contents and a soil texture of the sediments and chemical property such as nutrient elements and heavy metals. Interstitial water is investigated a nutrients such as nitrate, ammonium and phosphate. The study is considered 6 parts, Region 1 (Outer lake), Region 2, Region 3 which Region 2 and 3 is a sub-region of the Inner lake., and the Whole lake.

Lake Songkla, a lagoonal lake of Southern Thailand ( $100^{\circ} 4' E$  and  $7^{\circ} 5' N$ ) has a water surface area about  $1051 \text{ km}^2$  and a watershed is almost  $7,800 \text{ km}^2$ ., located in three adjacent province - Nakhon Sithammarat, Phattalung and Songkla. The lake is very shallow, about 1 - 2 m. and flat bottom.

This study is carries out the whole lake with 40 sample (August 78 and January 79). The sample are collect with core sampler, pH is immediatly and divided the sample into two portions. A portion for analysis of nutrients in interstitial water, is steriled by chloroform and stored at approximately  $4^{\circ}C$ . Another portion is transfer to polyethalene bag and stored at  $4^{\circ}C$ , dries in oven at  $105^{\circ}C$  overnight and ground until they pass trough a 0.5 mm., The dries powder to the oven an addition hour, after cooling in dissicator to stored in P V C vial until analyses

Methodology to analyses - nutrients in interstitial water were determined by Hach dr/2 Spectrophotometer. Sediments, Org-C was determined by Walkly Black method and reported as a percentage of the salt-free dry weight., analyses of total nitrogen and total phosphorus were determined by Macro-Kjeldahl Nitrogen and Vanadomolybdophosphoric yellow color method respectively., heavy metals were determined by Atomic Absorption Spectrophotometer, a sample to analyses were homogeneous by a mixed of hydrofluoric acid and perchloric acid.

The results are showned of August's sample except the nutrients elements in sediments are showned of January's sample also., in term of dry weight. Nutrients in interstitial water of the outer lake is greather than the inner lake except nitrate phosphate of the whole lake as well as all sub-region while ammonium is vary. Sediments, water contents and pH are almost equal by each region, pH of sediments in various parts are neutrol,, a texture, silt is a major composition and clay of various parts are constant., the nutrient elements, Org-C and total nitrogen are trend to increasing while total phosphorus is constant., and an enrichment of nutrient for the outer lake are greather than the inner lake., heavy metals, every element concentrate for the outer lake is more than the inner lake and are content in normal range except some element are too high concentrate such as Cu and Pb.

#### 40. Recommendation

Characterization of the lake bottom sediment project had to be completed within a short period and another parameter which can be to effect a environment were not investigated. So that for the future study, it should :

- 40.1 to analyse chlorinated hydrocarbon and heavy metals which to impact a food chain, in term of extractable and total concentration.
- 40.2 to study a distribution of the compound and the elements in soil profile
- 40.3 to analyse  $N-NO_3^-$  available in sediments
- 40.4 to analyse total N and total P in interstitial water
- 40.5 to study a corelation of nutrient elements and heavy metals between overlying water, interstitial water and sediments in these region.
- 40.6 to study another physical properties.

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