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A physico-chemical characteristic of soil samples for an environmental management study at lake ecosystem

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Abstract

The study area chosen for this investigation of soil quality was Samuthram lake, Thanjavur district to find out the impact of sewage wastes, open defecation, agricultural run-off etc., The pH of the sites was ranged from 8.1 - 8.4. The soil samples are alkaline in all the sites. TOC is important because it improves both the physical and chemical properties of soil and has several beneficial effects on agricultural soil quality. The percentage of total organic matter was ranged from 1.3 to 9.1. The nitrogen level of the study sites was ranged from 0.02% to a maximum of 0.14%. The phosphorous levels of the sites ranged from 0.01% to 0.08%. Phosphates are not toxic to people or animals unless they are present in very high levels. The result shows that the potassium levels ranges from a minimum of 0.02 – 0.04%. The above study indicates that pH and alkalinity of the soil samples are well above the safe limit. Other parameters are not more. In case of Agricultural run-off, open defecation, untreated sewage water may cause serious problem in future. So, there is an urgent management activity to protect this natural ecosystem.

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Introduction

Thanjavur being the foremost district of the Cauvery delta occupies an important position in the agricultural map of Tamil Nadu state. Since its formation, the district is called as the rice bowl of Tamil Nadu.

Samuthram lake was one of the most important irrigation and biologically significant lake at Thanjavur district. Samuthram Lake is located about 7 Km to the East of Thanjavur town on the Thanjavur Nagapattinam, Velangkanni Road (Fig. 1 & 2). The study area is bounded by STP in the West and Amman temple in the East. It has good network of roads and the Lord Siva Temple is situated at the central part of the lake is now removed by government authorities. The North west bank of the lake affected by high degree of anthropogenic activities like open defecation, ground drainage mixing etc.,

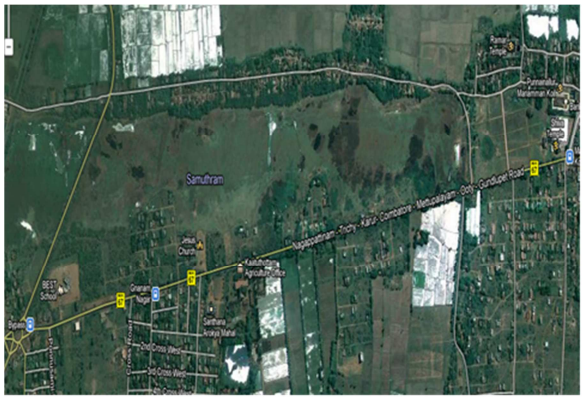

Fig. 1. Google map view of Samuthram lake

Lakes are not only the most important water resources in arid Central Asia, but also important resources for maintaining the unique ecosystem of the region (Huang, 2022). The selected area for the present work has not been studied so far, although such studies have been extensively carried out on other lakes of Thanjavur but not in our study area. The main objectives of the study is analyse the soil samples to evaluate any contamination will occur due to cloth washing, agriculture run off etc. The sample was collected during summer season. This work is carried out to find out the impact of sewage wastes, anthropogenic activities on soil quality.

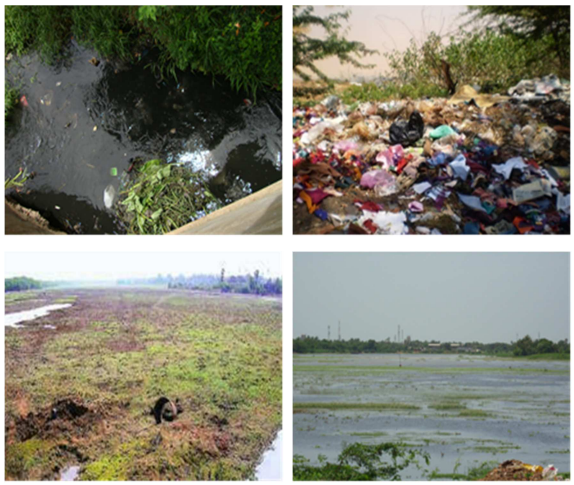

Fig. 2. Photography views of Samuthram lake

Materials and methods

Soil sampling

Selection of soil sampling site is decided on the basis of the overall objectives of the programs. The soil samples were collected from different locations in the Samuthram lake at Thanjavur. The samples were collected from the lake during summer and winter.

Bottom soil analysis

Bottom samples were collected at two different stations in both seasons by an Ekman dredge. The dredge was towed slowly for a distance of one foot (30 cm). The parameters are going to analyse based on the following procedures.

p^H

To preparation of 1:5 soil suspension and determine the pH electrometrically using glass electrode pH meter. The electrode was immersed in the unfiltered soil suspension and pH values were read directly from the digital screen.

Electrical conductivity (Trivedy and Goel, 1984)

The electrical conductivity of soil sample was measured with the help of a conductivity meter. To freshly prepared a 1:5 soil suspension by taking 20g of soil in 100ml of aerated distilled water. Shake mechanically for one hour, measure the conductivity of the soil suspension with conductivity meter by directly dipping the cell into the suspension. To

recorded the temperature of the soil suspension and convert the result at 25°C. Convert the result of conductivity at 25°C specifying the dilution of the soil suspension.

Total organic matter (TOM)

Estimation of organic carbon (Walkly and Black 1934)

Oven dried sample was passed through 0.5 mm sieve after which 10 grams of the sample was added to 500ml flask. 10 ml of 1N $K_2Cr_2O_7$ and 20 ml of Concentrated H_2SO_4 was mixed in it. Flask was then kept for 30 minutes for incubation, then the content was diluted to 200 ml with distilled water.10 ml of phosphoric acid and 1ml of DPA indicator was added to the sample and was then titrated against 0.5N ferrous ammonium sulphate till a brilliant green is obtained, which serves as an end point.

The organic matter of the vermicompost is oxidized by potassium dichromate utilizing the heat of dil. sulphuric acid (130±50°C). The unreacted (excess) dichromate is determined by back titration with standard ferrous ammonium sulphate solution using diphenylamine as an internal indicator.

When organic matter is ignited, first it loses moisture and the organic matter present in it. Loss on ignition is an index of organic matter contained matter contained in the manure**.**

About 2-5g of fresh sample was weighed in a clean, dry, pre- weighed silica crucible. The crucible with organic manure was kept in a muffle furnace and was heated at 550-600°C for 6 hrs. After drying, it was cooled it in desiccators and was reweighed to a constant weight. A loss in weight represents organic matter content in the manure.

Calculation

Organic matter% = 100 - % ash

% of ash content = (Weight of crucible +ash – Weight of empty crucible)/(Weight of crucible + manure before heating –Weight of empty crucible)

Nitrogen (Trivedy and Goel, 1984)

The determination of soil nitrogen based on kjeldahl digestion method. 10 g of soil sample was taken in to a 300 ml of kjeldhal flask and added 25ml of distilled water. Then 20g of catalyst mixture and 35ml of conc.H_2SO_4 was added and mixed by gentle swirling. The digestion of the soil sample was using low heat for 10 to 30 minutes. Then continue the digestion of the content will be changes the light yellow and heated it further about 1 hour to release all the residual nitrogen. Cool the digest and add about 100ml of distilled water and transfer the supernatant in 1 liter distillation flask. Then add 100 ml of 40% NaOH and few pieces of Zn. Then it placed on a conical flask of containing 25ml of boric acid and indicator. Titrate the content with 0.1 N HCl until the color changes to light brown to pink.

%N = a-b ×N of Hcl ×1.4/S

Total phosphorus (Olsen et al., 1954)

The total phosphorus is an estimated by colorimetric method employing ammonium molybdate and stannous chloride. 0.5g of soil was taken in a 100ml flask and moistens the soil sample with little water and added 2ml of conc. HNO_3 and 2ml of Conc. $HClO_4$ and its heated slowly. After that cool the flask 1 ml of $HClO_4$ was added and heated again. Again, the flask will be cooled and added 2ml of dilute H_2SO_4.after that filter the solution through what man No.42 filter paper and make up the final volume to 250 ml with distilled water in volumetric flask. 50 ml of filtered clear sample was taken in a conical flask and added 2 ml of ammonium molypdate followed by 5 drops of $SnCl_2$ solution. A blue color will appear and reading at 690 nm on a spectrophotometer using blank with a sample. Find use the concentration with the help of the curve.

% P={(mg P/L of digest)/20} × D

Potassium (Trivedy and Goel, 1984)

Determination of potassium in soil sample using flame photometric method was adopted to prepare the soil extract by leaching with 1 N ammonium acetate solution. This samples where only dissolved potassium is to be estimated, filter the sample through a filter paper to

remove any suspended matter. Find out the concentration of potassium using flame photometer. And also, preparation of standard calibration curve in the ranges of 0 to 1, 0 to 10 and 0 to 100 mg/l of potassium by using various standard solutions.

Potassium (%) = (K mg/L of soil extracts × V)/ (10000 × S)

Results and discussion

p^H

Soil pH indicates that the attempt to prevent soil characteristics such as availability of plant nutrients principally influenced by exchangeably calcium alone or $CaCO_3$ or be exchangeable sodium (Bear, 1964). The effect of plant growth is generally caused by toxic levels of soluble ions in the soil solution. Such effects can also arise from nutritional imbalances. Microbes mineralizes organic nitrogen to ammonia are less dependent on soil pH that the nitrifying organisms. The availability of soil phosphate is highly pH dependent. The pH of the sites was ranged from 8.1 - 8.4 (Table 1). The soil samples are alkaline in all the sites. This is due to the followings.

1. The discharge of sewage water or due to open air defecation.
2. Anthropogenic activities

Electrical conductivity

The term electrical conductance denotes the characteristic of a medium to pass electricity. Conductivity is defined as the conductance of a cube of one cm side of a substance is expressed in micromhos/cm or in dsm^{-1}. Conductivity is measured using Conductivity meter either analog or digital type. From the table.1 it is clear that the electrical conductance varied from a minimum of 0.34 mmho/cm to a maximum of 0.72 mmho/cm. The conductivity of soil samples is within the safe range for agricultural purposes. It is clear from the values that the electrical conductance value may be due to exchangeable ions (Hinrich, 1978) and organic carbon was significantly positive.

Total organic matter

Organic carbon (OC) is an essential part of all organic compounds. Soil organic matter generally contains approximately 56% OC. The following equation is used to estimate the total organic matter content of soil from OC measurements: % Organic Matter = % Organic Carbon x 1.78. Organic fraction of the soil is a complex of substances whose composition is determined in part by the plant and animal residues added to soil. Organic manure improves the content of organic matter in soil. The percentage of total organic matter was ranged from 1.3 to 9.1%. Results in the Table 1 show that the organic carbon is higher than the level that suits for the cultivation practices. This result quite does not match with NPK ratio, so it will need further parameters study.

Total nitrogen

Nitrogen exists in several forms in our environment. Nitrogen is a necessary nutrient for the growth of aquatic plants and algae. Not all forms of nitrogen can be readily used by aquatic plants and algae, especially nitrogen that is bound with dissolved or particulate organic matter. An abundance of nitrogen promotes rapid growth with a greater development of dark green leaves and stems. The nitrogen level of the study sites was ranged from 0.02 to a maximum of 0.14%. Higher amount of TN doesn't pose any serious effect to the soil.

Phosphorous

Phosphorus is a nutrient required by all organisms for the basic processes of life. Inorganic phosphate is phosphate that is not associated with organic material. Types of inorganic phosphate include orthophosphate and polyphosphate. Orthophosphate is sometimes referred to as "reactive phosphorus". Orthophosphate is the most stable kind of phosphate, and is the form used by plants. Orthophosphate is produced by natural processes and is found in sewage (Stevenson, 1982).

Polyphosphates (also known as metaphosphates or condensed phosphates) are strong complexing agents for some metal ions. Polyphosphates are used for treating boiler waters and in detergents. In water, polyphosphates are unstable and will eventually convert to orthophosphate (Yogodin, 1984). The

phosphorous levels of the sites ranged from 0.01% to 0.08%. Phosphates are not toxic to people or animals unless they are present in very high levels. Digestive problems could occur from extremely high levels of phosphate.

Potassium

Potassium levels in plants for optimal growth are between 2 and 3% of the dry weight. When K+ is limited to the plant life processes from Photosynthesis to moisture regulation of the plant are affected. Soil potassium levels are very much a function of the availability and uptake by the plant. In soils only a fraction of the potassium is available to the plant for uptake. The result shows that the potassium levels range from a minimum of 0.02 – 0.04%. The potassium levels are found suitable for the plant growth and the same has been reflected in the crops that have been grown in the study sites. This level is well below the safe limit.

Table 1. Examination of soil quality of the Lake

S. No	Parameters	Min	Max	Mean	σ
1	pH	8.10	8.40	8.24	0.11
2	EC mmho/cm	0.34	0.72	0.48	0.14
3	TOM (%)	1.30	9.10	4.66	3.11
4	Nitrogen (%)	0.02	0.14	0.05	0.05
5	Phosphorus (%)	0.01	0.08	0.04	0.03
6	Potassium (%)	0.02	0.04	0.03	0.01

High moisture content, low phosphate content and low pH of soil samples indicated soil pollution. In the right conditions, soil particles will cluster together and become stabilized by organic matter, fungal hyphae, bacterium secrelons and organo-metallic complexes (ABSA, 2006). Sanjeeb kumar 2008 made a study about the physico-chemical properties of soil of Laokhowa wildlife sanctuary, Nagon, Assam. Logging and grazing have direct effect on physical and chemical conditions of soil. The above study indicates that pH and alkalinity of the soil samples are well above the safe limit. Other parameters are within the safe limit.

Conclusion

The local people use this lake for fishing, irrigation, fuel wood collection, grazing, cattle washing and defecation of the lake bund are also common. The above study indicates that pH and EC of the soil samples are well above the safe limit. Other parameters are within the limit. The soil samples although smaller in the range of pollution has all the potential of becoming a major problem in years to come due to this continue encroachment and dumpling of wastes around the lake. This study is not enough furthermore specific study could be needed to protect this lake to aware the people. Hence, there is an urgent need to restore soil and water in and around the lake to protect the lake environment and to improve the quality of nature.

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