PEDOLOGICAL INVESTIGATIONS ON THE ECOSYSTEM OF VELLAYANI LAKE

By

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THESIS

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COLLEGE OF AGRICULTURE

VELLAYANI, THIRUVANANTHAPURAM

1994

DECLARATION

I hereby declare that this thesis entitled "**Pedological Investigations on the Ecosystem of Vellayani Lake**" is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

Vellayani,
1 -8-1994.

SANJEEV. V

Dedicated

to

Seetha

CERTIFICATE

Certified that this thesis entitled "**Pedological Investigations on the Ecosystem of Vellayani Lake**" is a record of research work done independently by **Mr. SANJEEV, V.** under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to him.

Vellayani,
1-8-1994.

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SANJEEV. V.

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INTRODUCTION

INTRODUCTION

Lakes form fragile ecosystem which mirror the nation's ecological wealth. They are important indicators of environmental degradation. Lakes play host to several species of birds and aquatic life and support the livelihoods of many thousands of fisher folk, apart from their aesthetic value of the landscape.

Lakes have a natural role of storing the precious rain water and maintain the ground water table, recharging the innumerable number of wells in the adjoining areas.

Lakes, in India, cover 0.2 million ha. In Kerala, the fresh water resources consist of the 44 rivers originating from Western ghats, 29 man made reservoirs, 10 fresh water lakes, countless number of village ponds, household ponds and temple tanks.

During the past few years, as a result of population pressure, lakes have been subjected to severe pressure and vast areas in the coastal belt have been drained, filled and reclaimed for human habitation,

industrial development, agricultural operations or similar activities. Thus these natural habitats which have been the abode of a fascinating group of plants and animals have been consistently encroached upon and their natural character destroyed resulting in serious ecological changes. The Vellayani fresh water lake represents one of these worst affected ecosystems in Kerala.

The Vellayani lake, a fully fresh water system, 11 kms south of Trivandrum city, is the only natural fresh water lake in the Trivandrum District. Lying between $8^{o}24'90"$ and $8^{o}26'30"$ N latitudes and $76^{o}59'08"$ and $76^{o}59'47"$E longitude the lake is bordered by the Thiruvallom and Nemom villages of the Neyyattinkara Taluk, stretching from Muttackad in the south to Vellayani in the north, the lake has only a present expanse of 224 ha. which is subjected to seasonal variation. Contradictory reports from different agencies are available on the extent of the lake. The lake bed is 0.1 to 1.0m below MSL. Sixty seven rivulets drain into this lake from the surrounding terrain and rainfall is the only source of water for this lake and it forms the watershed of 4 panchayats. The Vellayani reservoir is situated at the north-western end of the lake. The depth of the lake ranges

from 2 to 3 metres, occasionally reaching 5 to 6 metres during periods of heavy rain.

Vellayani lake now forms a typical example of man's intervention on nature. The lake is undergoing rapid transformation through indiscriminate encroachment. Paddy cultivation was introduced fifty years ago in the shallow, peripheral region by providing draining facilities. Step by step, this aggression on the body of the lake continued, reducing the area of the lake which is now confined to the deeper parts.

Coupled with this is the problem of siltation. Every inflow of water into the lake brings with it some amount of silt. Some of these get washed out when lake overflows, but silt outflow does not always match the inflow and the silt settles at the bottom of the lake, making it progressively shallow.

Though studies have been conducted in a detailed manner on many other lake systems in Kerala, not much is known about the bathymetry, water quality, genesis, morphology and characteristics of the lacustrine sediments,

production potential, land use pattern and degradation of the lake environment.

Present study was carried out to throw light on the nature and characteristics of the Vellayani lake ecosystem, the production potential of the soil, the extent of degradation of the lake ecosystem due to different land uses, so as to evolve a suitable management strategy to obtain maximum potential and conserve this ecosystem for future generations.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

1. Area and Distribution

Beeton Alfred and Chandler David (1966) reported that Lake Superior is the largest fresh water lake of the World, which has a surface area of 31,820 sqm. It is also the deepest of the great lakes with a maximum depth of 1,333 ft.

Moorman (1973) Reviewed the distribution and classification of wet lands of the World. He observed that large areas of aquepts & histosols dominated the nontropical wetlands of India. More than half of the 14 million ha. of tropical wetlands of US is seen near the Atlantic Gulf coastal plains.

Tamrazyan (1974) pointed out that USSR contains 35% of the surfaces of all lakes and over 62% of the lake water volumes of the entire earth.

De Silva (1978) reported that in Sri Lanka, a total area of 268,305 acres was covered by lakes and reservoirs.

Lakes of the World cover about 330,000 mi^2. of area and contain about 30,000 mi^3. of water, most of which is in large lakes (ie, a volume of more than 5 mi^3 or more). Large lakes of North America, Africa and Asia contain nearly three fourths of all the fresh liquid surfaoe on the continent (Nace Raymond, 1978).

According to Bowen Robert (1982), the total area of the three million lakes on the planet is $2.7x10^6$ km^2. Nineteen largest lakes of the World account for 38% of the total lake area.

Varshney (1978) reported that in India, about 3.9 million ha. of wetlands are present which can be grouped into fresh water, marine, brackish water and unclassified wet lands.

Rao Babu et al. (1981) pointed out that the lakes of Andhra Pradesh range in size from about 300 to 1,600 ha. and 10 to 40m in depth.

Aziz Abdul (1989) reported that lakes in India cover about 0.2 million ha.

Lake Kolleru in Andhra Pradesh had a surface water spread which varied from 135 km^2 at +3m MSL to 901 km^2 at +10m MSL. Lake Pulicat in Tamil Nadu occupied an area of 460 km^2 (Anonymous, 1993).

Aziz Abdul (1989) pointed out that there are nine fresh water lakes in Kerala and 29 man made reservoirs.

Pookot lake of Wynad District is one among the three fresh water lakes of Kerala and occupies an area of 7.5 ha (CWRDM, 1989).

Jayachandran and Joseph (1988 a,b) reported that Vellayani lake is one of the three pure fresh water lakes of the Kerala State and has a total area of 278.5 ha.

According to a report to the Govt, lake Sasthamkottah of Kerala is the largest fresh water lake of the State and has an area of 413.29 ha and an average depth of 6.7m (STEC, 1993).

2. Genesis and Formation

Madsen (1935) reported accounts of Morman lakes having been formed by trampling of cattle and sheep.

According to ranchers the lake was originally a grassy meadow surrounded by dry hills, into which livestock was turned to graze. Trampling made the basin water tight and created the lake.

Bowen Robert (1982) pointed out that lakes can be classified based upon the origin of the depression in which they occur and so they may be divided into teotonic, glacial, volcanic and sink hole.

According to Mallick & Suchindran (1984), two processes were responsible for the formation of Vembanad lake, in Kerala, India an initial tectonic phase followed by natural sedimentation process affected by water currents and tides.

Nair et al. (1988) have traced the geological evolution of Vellayani lake. During the past, tidal water had reached much inward along the lower basin of River Karamana and also along the basin of its then existing tributary from the south. Protected all around by steep hills, the area of the tributary basin had been totally submerged. Subsequent to the regression of the sea water, the deeper portions of the tributary became Vellayani lake.

2.2 Geology

Pennack (1945) pointed out that most of the exposed rocks over large sections of the rocky mountains are relatively insoluble granites, schists and gneisses which are low in carbonates, nitrates, and sulfates, as a result of which the lake waters above the plain zone are typically poor in dissolved salts.

CWRDM (1989) reported the geology of Pookot lake in Kerala. The watershed area of Pookot lake has archaean crystalline rocks which comprise of the charnockite, khondalite, granite and granitic gneisses.

The rock types observed at Sasthamkottah are mainly archaean in origin. The tertiary Varkala bed which extends along the coastal beds of Varkala formation is also observed in the area (STEC, 1993).

3. Characteristics

3.1 Physico-chemical properties

The great lakes consist of bicarbonate waters. Total alkalinity ranges from 46 ppm (as C_aCO_3) in Lake Superior to 113 ppm in Lake Michigan. The pH ranges from

8.0 to 8.5 for most of the water except Lake Superior where pH is 7.4. Sulfate concentrations are greater than chlorides in the upper lakes (U.S commission of fish & fisheries, 1900).

Wilson (1935) reported that a high proportion of New England lakes are ''extremely soft'' with bicarbonate concentration less than 10 mg $L.^{-1}$.

Moyle (1945 a,b), on the basis of distribution of aquatic plants classified lakes in Minnesota with a total alkalinity of less than 40 ppm as 'soft water lakes'. (pH 6.8 - 7.4 and the sulfate ion concentration less than 5 ppm) and those with alkalinity in the range of 40-250 ppm as hard water lakes (pH 8.0 - 8.8, sulfate concentration 50 ppm).

Cole (1966) pointed out that Roosevelt lake of Arizona is dilute chloride waters and bicarbonate is the second most abundant anion. Sulfates probably attain values up to 100 $mgVL^{-1}$ at times and a strong odour of hydrogen sulphide is present during summer stagnation. Waters of Lake Carl Pleasant of Arizona show sulfate and bicarbonate as principal anions.

Rao Babu et al. (1981) reported that the pH of Lake Hussain Sagar of Hyderabad varied between 7.3 and 8.5 during different months. He attributed the changes in pH to biological activities and also to industrial effluents.

Jayachandran and Joseph (1988 a,b) reported that the surface water of Vellayani lake was slightly alkaline almost throughout the year except January (pH 6.8), March (6.5) and April (6.8). The dissolved oxygen content of surface water ranged between 10 mgL^{-1} (September) to 12.5 mg L^{-1} (August). The salinity of bottom and top water was almost equal and varied between 0.068% (August) and 0.25% (March).

Analysis of Pookot Lake waters revealed that the pH ranged from 6.4 to 7.6 and the pH values remained almost constant during post monsoon and pre monsoon seasons. Chloride content of the lake varied from 4.76 ppm to 7.8 ppm. Electrical conductivity was found to be in the range of 26.7 and 63.1 micromhos cm^{-1} . Low alkalinity values were encountered which ranged from 10.7 ppm to 29.5 ppm. Sulphate content of the lake water varied between 0.08 ppm and 2.27 ppm (CWRDM, 1989).

3.2 Pedology

3.2.1 Morphological features

Characteristics of the Wet land soils of Kerala were reported by Money and Sukumaran (1973). Kari and Karappadam soils were light grey in color. According to them large amounts of partially decomposed plant materials present in the soil were responsible for their black colour. Lime shell deposits of lacustrine origin were commonly observed in surface and subsurface layers of Kayal soils. Yellow brown spots, mottlings, streaks and encrustations were found in almost all layers of kari and karappadam soils. Clayey texture of kari and karappadam soils accounted for their poor drainage while the silty clay texture of the kayal soils offered good drainage. Many of these soils especially kayal and karappadam soils were neutral in reaction under waterlogging.

USDA (Soil conservation staff, 1975) reported that the temporary and permanent wetting of soils will lead to a gley phenomena in wet land soils.

Dobrolovsky et al. (1977) pointed out that constantly wet horizons usually lack the well developed compact ferruginous segregation with distinct boundaries. These were generally found in the zone where oxidation and reduction alternate.

Ali et al. (1983) reported that the morphogenic features of low basin soils of Bihar showed an irregular texture indicating that these soils were developed from stratified materials over a long period. Clay content was found to increase with depth.

Bhargava and Abrol (1984) reported that the acid sulphate wet soils of Malabar coast of South India were generally high in decaying plant residues. A great deal of heterogenity existed with regard to the soil colour and mottling, indicating varying degrees of gleying, reduction and mottling.

Kyuma (1985) suggested that wet land soils are totally immature or only weakly developed as they have poorly developed morphology.

CWRDM (1989) reported that the soils under forest ecosystem around Pookot lake, Wynad were Yellowish brown to dark brown in colour and those under grass land were reddish to Yellowish red in colour.

3.2.2 Physical characteristics

Money (1956) classified the kari soils of Kuttanad wet lands as clay or clay loam, with more sand percentage in the upper horizons. Pillai (1964) and Venugopal (1969) reported lowest bulk density for these soils. Varghese (1973) reported a particle density of 2.08 - 2.76 g cc^{-1} , a bulk density of 0.96 - 1.62 g cc^{-1} and a pore space of 31.58 - 62.53% for kari soil profile.

Soil Survey Staff (1975) reported that kayal soils of Kuttanad were clay loam throughout the profile, while karappadam soils were clay loam in the surface and silty loam in the lower layers.

Sreedevi et al. (1975) observed that clay was the dominating particle size fraction in the natural wet lands of Kerala. Karappadam soils were dominated by silt and clay fractions and kole soils had the highest percentage of clay.

Kawaguchi and Kyuma (1977) observed that physical properties of wet land soils were generally poor because of their high clay contents and low organic matter. Soil texture was generally fine in the tropical wet land soils containing more than 45% clay. This was true for about 46% of the wet lands studied by them.

Antony (1982) analysed the soil profile of Vellayani and classified the soil as loamy. The percentage coarse sand was 42.0 at a depth of 21 cm and 36.0 at a depth of 180 cm. The clay percentage varied between 13.8 at 21 cm and 23.6 percentage at 180 cm depth.

Ali et al. (1933) reported that for the wet land soils of Ranchi district of Bihar, the textural changes were developed over different sedimentary (stratified) parent material over a long period. Clay content and water holding capacity increased with depth whereas specific gravity and apparent density decreased.

Jackson (1984) investigated the physical properties of wet land soils and found out that in most profiles, there

was a very large variation of physical properties and content of organic matter with depth.

Wilding and Rehage (1985) reported that many soils with aquic moisture regimes had strong textural differentiation between surface and sub surface horizons. This was mainly due to illuviation of clay into finer textured sub soils. Sedimentary discontinuities, ferrolysis, in situ weathering of primary minerals and lithorelics, neoformation and differential transport of eroded sediments had also been observed.

Raju (1988) pointed out that the predominant textural class of Kuttanad soils was clay to clay loam. Sandy pockets were common in kari soils. The bulk density of these soils were lower due to organic matter content.

Unnikrishnan (1993) observed that the texture of Vellayani lake soil varied from sandy clay loam in the surface layer to clay loam in the deeper layers. The bulk density varied between 0.95 - 1.48 $g.cc^{-1}$ and the particle density was in the range 1.9 - 2.6 $g.cc^{-1}$.

3.2.3 Chemical Characteristics

3.2.3.1 Soil acidity

Kabeerathumma (1969) and Ghosh *et al*. (1976) reported that *kayal* and *karappadam* soils of Kuttanad were less acidic than *kari* soils.

Ponnamperuma (1972) studied in detail the pH values of submerged soils and sediments. According to him irrespective of initial pH, soils on wetting and continuous submergence attained a near neutral pH.

Kawaguchi and Kyuma (1977) collected 410 samples of wet land soils from tropical Asia. The mean pH reported was 6.0. They observed that soils with exceptionally low pH were either peaty or brackish sedimentary and were frequent in South East Asia.

Alice (1984) reported exchangeable aluminium as the main constituent of soil acidity in the wet land rice soils of Kerala.

Nair (1988) reported that the pH of wet land soils of Kerala varied from 3.6 - 6.5 and drying of these resulted in the decrease of pH, believed to be due to oxidation of Fe^{2+} to Fe^{3+}.

The soils around Pookot lake of Wynad are fairly acidic with pH ranging between 4.7 and 5.6 (CWRDM, 1989).

Unnikrishnan (1993) studied the soil profile of Vellayani and reported that the wet pH of the soil was 4.5 at the surface and 6.1 at the bottom layer whereas the dry pH was 4.2 at the surface and 4.9 at the bottom layer.

3.2.3.2 Soil Fertility

Total N content of the acid sulphate wet lands of Kerala was reported to be high due to high organic matter. Available nitrogen content of 140 - 590 ppm was reported for kari soils of Kuttanad (Pillai Sukumara, 1964).

Kyuma (1985) reported that of the 410 samples of tropical Asian wet lands, about 78% samples contained only <0.15 percent total nitrogen. Overall mean was reported to

be as low as 0.13 percent. Indian wet lands were reported to be low in their organic matter probably due to a drier climate. The N status of wet lands were found to be better than that of uplands. Total P_2O_5 content was reported to be less than 400 ppm.

The soils around Pookot lake are fairly rich in total nitrogen content. The nature of vegetation plays a very important role in the enrichment of soil with nitrogen (CWRDM, 1989).

Unnikrishnan (1993) reported that total nitrogen content of Vellayani wet land soil was between 0.01 to 0.07%. The total phosphorous content varied between 0.01 and 0.017% and potassium content varied between 0.125% and 0.421%.

The CEC values of kari, karappadam and kayal soils were in the range of 15.4 - 40.7, 16.4 - 37.8 and 12.8 - 17.0 cmol (+) kg^{-1} respectively (Money and Sukumaran, 1973)

Hassan (1980) reported a comparatively low values of CEC, organic matter and total and available nitrogen in the ribbon valley laterite wet lands of Kerala.

Kyuma (1985) from a study of tropical Asian wet lands observed the overall mean of CEC as 18.6 cmol $(+)^{-1}$ kg^{-1}.

Marykutty (1986) pointed out that the values obtained for CEC for the kayal soils of Kuttanad were in the range of 10.8 - 12.3 cmol(+)kg^{-1} .

Iyer (1986) reported a CEC of 11.15 - 46.6 cmol(+) kg^{-1} for wet lands of Kerala CEC varied significantly between soils.

The CEC values of Vellayani wet land soil ranged between 8.2 and 14.27 cmol (+) kg^{-1} (Unnikrishnan, 1993).

3.2.3.3 Organic carbon/Organic matter

Money and Sukumaran (1973) reported that the wet land soils of Kuttanad contained fairly large amounts of organic matter.

Bhargava and Abrol (1984) pointed out that there was wide variation in the organic matter content of the wet land soils of Malabar coast, South India (0.5-40.5 per cent).

Marykutty (1986) reported that the organic carbon values of the kayal soils of Kuttanad varied between 0.19 - 7.28%.

According to Unnikrishnan (1993) the organic carbon values for wet land soils of Vellayani varied between 0.42% and 1.25%.

4. Degradation of Fresh water lakes

Rao Babu et al. (1981) pointed out that the uncontrolled growth of undesirable weeds, heavy industrial development and release of untreated sewage into lake Hussain Sagar has led to hypereutrophication and severe pollution of the lake.

Aziz Abdul (1989) reported that large scale reclamation, unscientific land use pattern and watershed management over the past nearly four decades have depleted the Vellayani lake substantially and the various alternatives uses the reclaimed areas were put to have not been economically quite sound. Roads have been laid across the lake for transportation.

CWRDM (1989) pointed out the sedimentation problem of Pookot lake. Dykes were constructed within the lake using clay and other materials to form small tanks for fingerlings. These areas on the fringes of the lake transformed into ideal places for sediment deposition, leading to the reduction in the capacity of the lake.

Chembukayal, which is a part of the great Vembanad kayal ecosystem is shrinking in its area. The kayal area has been reduced to 12,700 ha from the original 36,500 ha. As a potential recharging source for drinking water for the adjoining areas, any disturbance of the ecosystem will have reperucussions on the social frame work of the region. (Kerala State committee on Science, Technology and Environment, 1989).

A report on the changing face of India's lake (Anon, 1993) throws light on the following lake ecosystems which are fast degrading.

a. Chilka lake, Orissa : The area of Chilka lake has shrunk from 2,200 km^2 originally to about 915 km^2. Nearly 200 km^2 of the waterspread is covered by weeds.

b. Ansupa lake, Orissa: The largest fresh water lake in the State is turning into a swamp due to heavy exploitation of vegetation around Ansupa, accompanied by siltation and increased growth of hyacinth and algae.

c. Dal lake, Kashmir: The present area of this lake is 12 km^2 - less than half of what it was a few decades ago. The gardens and trees that have come up along the fringes of the lake have contributed substantially to the reduction of the lake's area.

d. Powai lake, Bombay : The lake is shrinking rapidly due to siltation, caused by heavy soil erosion in the hills. The construction of unauthorised structures and quarrying are the main causes of erosion.

e. Kolleru lake, Andhra Pradesh: The roads and bridges across Kolleru have disrupted the organic continuity of the lake. Sewage and pesticides from the nearby towns contaminate the lake. The reduced catchment area has led to eutrophication, loss of drinking water and declining fish catches.

Kerala State Committee on Science, Technology and Environment (1993) pointed out the degradation of Sasthamkottah lake ecosystem. As the catchment of Sasthamkottah is in the process of laterisation, the inhabitants are engaged in laterite brick quarrying which causes the uprootment of several trees. Dipping of coconut leaves in the lake water for curing depletes the available oxygen.

Kerala Statistical Institute (1993) reported that nearly 15% of the wetlands of Travancore region is utilised for cultivation of perennial tree crops and 3% for non agricultural uses like brick making. Paddy is cultivated only in slightly more than 3/4 of the area classified as wet lands.

MATERIALS AND METHODS

MATERIALS AND METHODS

To study the morphology and physico chemical characteristics of soils of Vellayani lake, nine specific locations in and around the lake system were selected. Locations were so selected to represent both the Kayal lands as well the lands reclaimed by human activity.

Profile pits were dug at nine locations up to a depth of 150 cm. Information on the site, general information on the soil and profile description were made as per the guidelines suggested by Soil Survey Staff (1975). Samples were collected from different horizons of each profile. Five surface samples, at a radial distance of 100 m from each profile were collected. A total number of 82 samples were thus collected. Climatological data were collected from the Department of Agronomy, College of Agriculture, Vellayani.

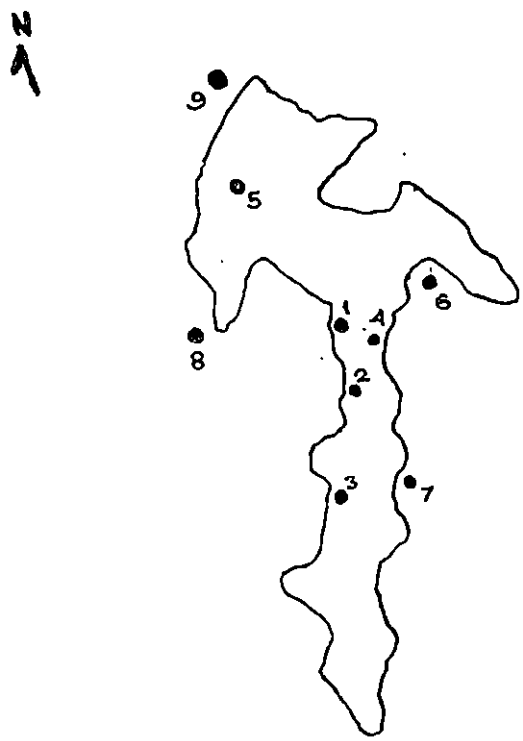
Apart from the above samples, water samples and soil samples were taken at an interval of 15 days and analysed for the periodical variation in pH, EC, sulphate and chloride.

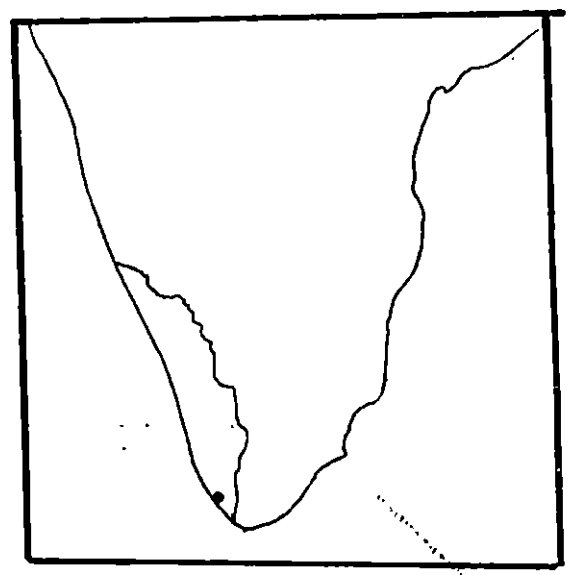
VELLAYANI LAKE

LOCATION MAP scale 1:50,000

Latitude: 8° 24' 90" N

Longitude: 76° 59' 08" E





1. PROFILE 1 - LAKE BOTTOM
2. PROFILE 2 - LAKE BOTTOM
3. PROFILE 3 - LAKE BOTTOM
4. PROFILE 4 - LAKE BOTTOM
5. PROFILE 5 - LAKE BOTTOM
6. PROFILE 6 - LAND USE - COCONUT
7. PROFILE 7 - LAND USE - BANANA
8. PROFILE 8 - LAND USE - RICE
9. PROFILE 9 - LAND USE - VEGETABLES

Laboratory investigations

The wet land soil samples were air dried, powdered and passed through a 2 mm sieve and stored in airtight bottles. These sieved soil samples were subjected to physical and chemical analysis.

Physical Analysis

a) Single Value constants

The single value Physical constants viz. bulk density, particle density and porosity, were determined using Keen Raczkowski box as described by Piper (1950).

b) Mechanical analysis

The mechanical composition of the soil samples was determined by International Pipette method (Piper, 1950). The percent content of various size fractions were determined. After this, the textural classification was done.

Chemical analysis

a) pH of the fresh and air dried soil samples were determined in water (1:2.5) and 1M KCl (1:2.5 soil and KCl) using Elico pH meter (Jackson, 1973).

b) Electrical conductivity of the 1:2.5 soil and water extract was read using an 'Elico' conductivity bridge (Jackson, 1973)

c) Organic carbon and organic matter were determined by modified Walkley and Balck wet digestion method. (Jackson, 1973).

d) Total nitrogen, phosphorus and potassium were determined by standard procedures described by Jackson (1973).

e) Cation exchange capacity was determined by neutral normal ammonium acetate leachate method as described by Jackson (1973).

f) Exchangeable hydrogen and aluminium were estimated in the 1 M KCl extract (Black, 1965).

Periodical analysis of soil and water

a) Soil analysis

The saturation extract of the soil was made and analysed for chloride and sulphate.

b) Water quality analysis

Water samples were analysed for the chloride and sulphate as per the procedures suggested by Chopra and Kanwar (1982).

Cartography

1. Land use map

Revenue map was used as the base map and the area was traversed to find out the present land use.

2. Bathymetry map

The entire lake area was traversed in a boat and the depth was recorded at equal interval from the banks.

3. Fertility map

The available N, P and K content of the surface samples were determined as per the standards procedures suggested by Jackson (1973) and based on this the soil was classified as high, medium and low nutrient soils. This was used for the preparation of soil fertility map.

4. Map showing reduction in lake area

The map of the lake prepared in 1927 was used as the base map. Another map showing the present status of the lake was prepared from satellite imagery of the area. This was superimposed over the original map to show the extent of reclamation.

RESULTS

RESULTS

1. Climatic parameters

1.1 Mean monthly maximum temperature

The temperature readings over the past eight years shows that the mean monthly maximum temperature does not show much variation. The temperature reached a peak value of 33.2^{o}C during April and August recorded the least value of 29.6^{o}C. Over the years, there has been a slight decrease in the maximum temperature recorded. The annual mean temperature recorded during 1986 was 31.58^{o}C whereas the mercury dipped to 30.57^{o}C during 1993. However, the mean monthly maximum temperature over a period of eleven years (1983-1993) worked to be 31.07^{o}C During a year, April and May remain as the hottest months and October - November, the coldest (Table 1).

1.2 Mean monthly minimum temperature

The mean monthly minimum temperature follows the same trend as that of mean maximum. The readings were high during April-May when the thermometer reading was 24.7^{o}C. The lowest value was recorded during January (21.1^{o}C) . The

Table 1. Monthly variation of maximum temperature (^{O}C) for a period of 11 years (1983-1993)

Station: Vellayani

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov.	Dec.
1983	32.8	32.8	32.8	33.6	32.9	31.3	30.5	28.4	29.4	31.2	30.9	31.2
1984	31.2	32.5	32.2	32.4	32.8	30.3	28.9	28.8	30.3	28.6	30.7	30.6
1985	30.7	31.8	32.4	33.5	32.5	28.5	28.2	28.6	30.3	30.6	29.8	30.2
1986	31.9	31.9	31.8	34.5	33.7	31.2	31.0	30.3	30.3	30.8	30.6	31.0
1987	31.7	31.6	33.6	33.8	33.4	30.8	31.2	30.2	31.3	30.4	30.8	31.5
1988	31.8	31.7	33.1	32.9	33.1	30.3	30.7	30.5	29.9	32.0	31.6	32.4
1989	31.6	31.8	32.8	32.0	31.0	28.3	31.2	29.0	29.3	30.2	31.2	31.1
1990	31.5	32.6	33.6	33.4	31.3	30.4	29.3	29.0	31.1	29.9	30.5	30.1
1991	30.8	31.1	32.3	33.4	33.3	29.5	29.4	29.4	30.7	30.5	30.3	30.6
1992	30.2	30.8	32.1	33.0	31.7	29.8	28.9	28.9	29.3	28.9	29.1	30.3
1993	30.3	31.3	32.3	32.6	32.1	30.0	28.8	29.4	30.6	29.8	29.8	29.9
Monthly mean	31.3	31.8	32.6	33.2	32.5	30.0	29.8	29.3	30.2	30.3	30.5	30.8

annual mean values of minimum temperature over a period of 11 years (1983-1993) were almost constant, at around 23°C (Table 2).

1.3 Monthly mean temperature

The monthly mean temperature was lowest during January and December with values 26.4°C and 26.3°C respectively. This shows that the difference between maximum and minimum temperature was highest during these months, April and May recorded high values with mercury rising up to 28.9°C (Table 3). The mean temperature values do not show much variation when compared to values over a period of 50 years (1943-1993).

1.4 Precipitation

A scan through the rainfall values of the past 50 years reveal that the mean rainfall of the location is 1840 mm. However, the mean annual rainfall for the past eleven years (1983-1993) is only 1520 mm. Rainfall values during the period of study recorded high values of above 1800 mm. Maximum rainfall was obtained during June - July (Table 4).

1.5 Evapotranspiration

The ET was high during April - May when the temperature was highest. The lowest value was recorded during June when the bright sun shine hours was lowest.

Table 2. Monthly variation of minimum temperature (^{o}C) for a period of 11 years 1983-1993

Station: Vellayani

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov.	Dec.
1983	20.5	22.1	22.6	24.7	24.4	23.9	22.9	22.8	23.1	23.4	21.6	23.4
1984	23.6	25.3	23.5	19.2	20.4	22.9	23.7	23.8	23.8	22.1	23.8	22.6
1985	22.9	23.8	25.6	22.3	24.2	23.1	22.4	23.6	23.6	22.8	23.0	22.8
1986	21.8	20.8	20.8	23.5	23.1	22.6	22.9	22.4	23.4	22.6	21.4	21.2
1987	21.4	18.8	23.7	25.2	24.1	23.3	24.6	23.6	23.4	23.2	23.4	22.7
1988	20.9	22.3	24.8	24.5	25.3	24.2	23.4	23.8	23.8	24.5	22.6	21.0
1989	21.8	20.9	23.1	24.8	25.0	23.7	24.2	23.0	23.1	23.3	22.5	21.6
1990	20.1	23.4	24.2	24.8	24.1	24.0	22.9	23.7	23.9	23.5	23.6	21.7
1991	22.3	21.3	23.9	25.4	25.7	24.0	23.4	23.4	24.1	23.8	23.5	20.5
1992	20.4	21.9	22.2	25.4	24.9	24.2	23.0	23.3	23.3	22.7	23.0	21.5
1993	20.5	21.0	23.1	24.7	25.1	24.1	22.8	23.6	23.5	23.4	23.1	23.2
Monthly mean	21.5	22.0	23.4	24.0	24.2	23.6	23.3	23.4	23.5	23.2	22.9	22.0

Table 3. Monthly variation of mean temperature(^{O}C) for a period of 11 years 1983-1993

Station : Vellayani

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov.	Dec.
1983	26.7	27.5	27.7	29.2	28.7	27.2	26.7	25.6	26.3	27.3	26.3	27.3
1984	27.4	28.9	27.9	25.8	26.6	26.0	26.3	26.3	27.1	25.4	27.3	26.6
1985	26.8	27.8	29.0	27.9	28.4	25.8	25.3	26.3	26.9	26.7	26.4	26.5
1986	26.8	26.3	26.3	29.0	28.4	26.9	26.9	26.3	26.8	26.7	26.0	26.1
1987	26.5	25.2	28.6	29.5	28.9	27.0	27.9	26.9	27.3	26.8	27.1	27.1
1988	26.3	27.0	28.9	28.7	29.2	27.3	27.0	27.1	26.8	28.2	27.1	26.7
1989	26.7	26.3	27.9	28.4	28.0	26.0	27.7	26.0	26.2	26.7	26.8	26.3
1990	25.8	28.0	28.9	29.1	27.7	27.2	26.1	26.3	27.5	26.7	27.0	25.9
1991	26.5	26.2	26.6	29.4	29.4	26.7	26.9	26.4	27.4	27.1	26.9	25.5
1992	25.3	26.3	27.1	29.2	28.3	27.0	25.9	26.1	26.3	25.8	26.0	25.9
1993	25.4	26.1	27.7	28.6	28.6	27.0	25.8	26.5	27.0	26.6	26.4	26.6
Monthly mean	26.4	26.9	27.9	28.6	28.4	26.8	26.6	26.3	26.9	26.7	26.7	26.4

Table 4. Periodical variation of precipitation (mm) for a period of 11 years 1983-1993

Station : Vellayani

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov.	Dec.	Total	Rainy days
1983	-	-	-	59.5	113.5	154.0	121.0	217.0	133.4	50.6	152.3	108.2	1109.5	101
1984	35.6	85	46.4	191.0	100.0	215.8	131.6	22.4	83.2	201.8	120.6	5.4	1238.8	101
1985	61.2	26.0	8.1	38.4	123.0	322.1	46.0	21.7	-	594.0	240.0	104.8	1585.3	82
1986	21.6	8.0	8.6	125.5	132.1	224.3	94.4	449.3	102.4	80.2	183.4	25.4	1533.2	95
1987	-	-	4.8	48.0	83.0	223.1	20.4	272.9	125.7	296.9	182.3	233.2	1490.3	104
1988	0.0	6.8	55.3	62.5	51.2	307.0	197.8	100.3	320.6	11.6	78.8	6.4	1197.4	98
1989	4.4	-	43.3	129.2	108.4	347.4	215.2	89.4	222.8	195.3	100.1	31.5	1487.0	120
1990	3.6	-	12.8	170.6	369.8	147.2	229.3	27.9	78.2	110.3	524.8	22.9	1542.7	113
1991	28.6	26.5	40.0	31.2	87.4	669.3	272.0	154.5	22.4	204.5	247.1	20.0	1803.5	110
1992	35.0	-	-	6.0	90.9	613.3	224.7	67.8	76.3	412.0	281.0	15.1	1822.1	109
1993	-	2.8	36.3	39.6	221.0	391.3	224.2	33.2	78.8	311.6	396.3	127.3	1862.4	119
Monthly mean	17.3	14.1	23.2	82.0	134.6	328.5	161.5	132.4	113.1	222.0	227.9	63.7	1520.3	

Table 5. Weather data of the station (for a period of 50 years from 1943 to 1993)

Station : Trivandrum Lat. 8° 29' N

Elevation : 64 m Long. 76° 57' E

Annual Rainfall : 1840 mm. Ustic moisture regime

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly Rainfall (mm)	20.0	20.0	44	122	249	331	215	164	123	272	207	73.0
Monthly air temperature (°C)	27.0	27.0	28	29	28	26	26	26	27	27	27	27
Monthly ET (Thorntwaite, mm)	142.3	129.7	152.2	158.5	156.7	125.9	129.6	128.4	140.9	143.7	138.1	142.3

Classification

FAO/UNESCO (1988)	:	Umbric Fluvisols
USDA	:	Tropic Fluvaquent, fine, kaolinitic, isohyperthermic
Diagnostic criteria	:	FAO : Diagnostic horizons : Gleying USDA : Diagnostic horizons : Gleying Soil Moisture regime : Ustic

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Location

Lat : 8^{o} 26' 3" N Long : 76^{o} 49' 5" E Altitude : 5m

Pedons at a distance of 400-500 m.

Pedon 1 : Eastern side of instructional farm, 60 m North of new bund and 60 m East of bund on reclaimed area (near boat shed).

Pedon 2 : 70 m South of bund (to Kakkamoola), 20 m East of the fence.

Pedon 3 : 65 m South of bund to Vavvamoola, 150 m east of the wall.

Pedon 4 : 100 m North of the new bund, 75 m west of the road.

Pedon 5 : 50 m South of the bund at Punchakkari, 70 m East from the road.

General land form Topography : Flat

Physiographic unit : Flat or almost flat

Slope : 1%

Position of site : Centre of a drained field

Surface character : Rock out crop : nil. Stoniness : Nil

Cracking : Cracks on drying

Slaking/crusting : Nil

Slope process : Erosion : Nil

Parent material : Fluvial and lacustrine deposits

Texture :

Effective soil depths : 150 cm

Water table : Depth : 70 cm Kind :

Drainage : Poorly drained

Permeability : Poor

Flooding : Frequency : Flooded throughout

Moisture condition profile : Wet throughout

Land use : crops :

Vegetation : type :

Profile description

Pedon 1

Ap1: 0-7 cm brown 10 YR 4/4 (moist) and Light yellowish brown 10 YR 6/4 (dry), sandy loam, coarse granular, non sticky, non plastic when wet, friable when moist and soft when dry, weakly cemented, many micro pores, fine to medium fibrous roots, wavy clear and sharp boundary. pH (wet): 4.5; 4.4 (dry).

Ap2: 7-20 cm, Greyish brown 2.5 Y 5/2 (moist), 10 YR 5/4 (dry) Brownish & yellowish mottlings, clay loam, fine, slightly sticky, cemented with clay, many micro pores, fibrous roots, clear smooth boundary pH - 5.0 (wet). 3.9 (dry).

Ap3: 20-40 cm, Dark greyish brown 2.5 Y 4/2 (moist), 10 YR yellowish brown 5/4 (dry), many mottlings, clayey, sticky when wet, cemented, very few roots, diffusing boundary. pH - 5.5 (wet) 4.4 (dry).

Table 6. Physico-chemical characteristics of pedon 1

Physical Characteristics						Surface samples				
	AP1	AP2	AP3	C1	C2	1	2	3	4	5
Texture	Sandy-loam	Clay	Clay	Clay	Clay	Clay	Clay	Clay	Clay	Clay
% C.S	60.6	27.4	4.4	2.2	3.6	1.8	1.8	3.0	6.0	24.8
% F.S	15.2	7.2	2.2	1.8	2.0	1.8	1.0	2.8	8.5	6.1
% silt	11.0	10.0	34.0	24.0	10.0	18.0	14.0	18.0	20.0	11.0
% clay	13.0	56.0	60.0	70.0	88.0	80.0	86.0	75.0	72.0	51.0
B.D $g.cc^{-1}$	1.5	1.06	1.11	1.05	1.08	1.09	1.07	1.09	1.07	1.04
P.D $g.cc^{-1}$	2.0	1.80	1.80	1.70	1.71	1.81	1.90	1.92	1.81	1.86
% Porosity	48.17	50.16	42.46	47.21	43.30	42.37	46.21	43.06	44.35	50.56
Chemical Characteristics										
pH (wet)	4.5	4.5	6.0	6.4	6.6	6.5	6.3	6.2	6.3	5.2
pH (dry)	4.4	3.9	4.4	4.1	5.1	5.7	4.1	3.7	3.9	4.1
pH (KCl)	3.5	3.0	3.5	3.4	3.8	3.3	3.4	3.3	3.3	3.7
EC dSm^{-1}	–	–	–	–	–	–	–	–	–	–
O.C%	0.87	1.78	2.79	3.07	3.03	3.89	3.97	2.70	2.92	2.44
O.m%	1.49	1.92	4.64	5.16	5.16	6.6	6.7	4.62	4.9	4.7
CEC $cmol(+)kg^{-1}$	10.7	13.9	15.9	18.2	21.9	15.8	16.6	16.2	15.7	15.9
Exch.H me $100g^{-1}$	0.08	0.16	0.16	0.16	0.24	0.32	0.08	0.08	0.16	0.32
Exch.Al me $100g^{-1}$	0.24	0.88	0.40	0.80	0.16	1.36	1.32	2.56	1.60	1.12
Total N%	0.014	0.204	0.336	0.504	0.542	0.204	0.196	0.280	0.252	0.014
Total P%	0.025	0.038	0.027	0.040	0.037	0.050	0.035	0.038	0.031	0.042
Total K%	0.260	0.640	0.440	0.400	0.280	0.280	0.340	0.240	0.360	0.300

C1: 40 - 70 cm. Dark greyish brown 5 Y 4/2 (moist), olive 5Y 4/3 (dry), clayey, massive, puddled, very sticky when wet, highly cemented, roots nil, diffusing boundary. pH 5.5 (wet), 4.1 (dry).

C2: 70 - 100 cm, Very dark greyish brown 5Y 3/2 (moist), greyish brown 2.5 Y 5/2 (dry), mottlings nil, clayey, massive, very sticky, roots nil, pH 6.0 (wet). 5.1 (dry).

Pedon 2

Profile description

Ap1: 0-5 cm, Dark brown 10 YR 3/3 (moist) and brown 10 YR 5/3 (dry). Brownish mottlings, sandy loam, fine granular, slightly sticky when wet, cemented with clay, many macro and micro pores, many fibrous roots of rice and weeds, smooth gradual boundary. pH 6.0 (wet), 3.8 (dry).

Table 7. Physico-chemical characteristics of pedon 2

Physical Characteristics	Surface samples								
	AP1	AP2	C1	C2	1	2	3	4	5
Texture	Sandy loam	Clay	Clay	Clay	Clay	Clay	Clay	Clay	Clay
% C.S	10.0	6.1	3.0	1.5	5.7	6.2	3.2	5.2	4.6
% F.S	2.1	3.6	1.5	1.0	2.0	2.1	1.5	1.0	1.8
% Silt	10.0	7.0	20.0	17.0	8.0	10.0	18.0	15.0	10.0
% Clay	77.0	81.0	80.0	80.0	85.0	83.0	78.0	81.0	87.0
B.D $g.cc^{-1}$	1.11	1.02	1.29	1.13	1.06	1.11	1.12	1.07	1.13
P.D $g.cc^{-1}$	2.11	1.18	2.30	1.93	1.90	2.26	2.21	1.75	1 .89
% Porosity	49.06	45.24	46.58	47.41	46.60	46.40	52.45	43.98	47.64
Chemical Characteristics									
pH (wet)	6.0	5.6	6.7	6.8	6.2	6.1	6.2	6.5	6.7
pH (dry)	3.8	4.2	3.9	3.9	4.2	4.2	4.0	4.3	4.4
pH (KCl)	3.0	3.3	3.1	3.5	3.2	3.3	3.1	3.2	3.5
EC dSm^{-1}	–	–	–	–	–	–	–	–	–
O.C%	1.85	2.24	2.92	2.92	2.33	2.27	2.25	2.58	2.54
O.m%	3.18	3.85	5.02	5.02	4.01	3.90	3.87	4.44	4.36
CEC $cmol(+)kg^{-1}$	12.6	14.1	19.80	19.0	13.9	14.2	12.8	14.1	13.5
Exch.H $me100g^{-1}$	0.16	0.16	0.24	0.16	0.24	0,16	0.14	0.16	0.26
Exch.Al $me\ 100g^{-1}$	1.68	0.80	1.12	0.16	0.72	0.72	0.88	0,24	0.16
Total N%	0.280	0.392	0.476	0.560	0.204	0,168	0.280	0,252	0.280
Total P%	0.056	0.037	0.037	0.040	0.037	0.027	0.018	0.035	0.026
Total K%	0.260	0.200	0.340	0.220	0.200	0.200	0.180	0.280	0.120

Ap2: 5-25 cm, Dark greyish brown 2.5 Y 3/4 (moist) and brown 10 YR 5/3 (dry). Brown to yellow mottlings, clayey, fine granular, slightly sticky, cemented with clay, micro pores more, a few fibrous roots, diffusing boundary pH 5.6 (wet), 4.2 (dry).

C1: 25 - 60 cm. Dark greyish brown 2.5 Y 3/2 (moist) and olive grey 5 Y 4/2 (dry), clayey, massive, sticky, cemented, roots nil, diffusing boundary. pH 6.7 (wet, 3.8 (dry).

C2. 60 - 100 cm. Dark greyish brown 2.5 Y 3/2 (moist) and olive grey 5Y 4/2 (dry), clayey, massive, sticky, cemented, roots nil, pH 6.8 (wet), 3.9 (dry).

Pedon 3

Profile description

Ap1: 0 - 10 cm. Olive 5 Y 4/3 (moist) and brown 10 YR 5/3 (dry) no mottlings, clay loam, fine granular, slightly sticky, cemented with clay, many macro and micro pores, many fibrous roots of rice and weeds present, diffusing boundary. pH 4.8 (wet) 4.1 (dry).

Table 8. Physico - chemical characteristics of pedon 3

Physical characteristics	Surface samples								
	AP1	AP2	C1	C2	1	2	3	4	5
Texture	Clay loam	Clay	Clay	Clay	Clay	Clay	Clay	Clay	Clay
% C.S	40.0	4.1	2.1	1.5	3.4	4.5	2,8	6.1	3.7
% F.S	7.0	1.5	1.0	0.8	1.5	1.6	1.0	2.1	1.9
% Silt	10.0	14.0	12.0	10.0	12.0	1.0	16.0	15.0	1.6
% Clay	47.0	86.0	85.0	88.0	80.0	2.1	82.0	79.0	81.0
B.D $g.cc^{-1}$	1.06	1.06	1.31	1.00	1.08	1.10	1.09	1.10	1.14
P.D $g.c^{-1}$	2.27	2.00	2.07	1.82	2.07	2.29	2.56	2.39	2.35
%Porosity	52.70	56.35	54.6	58.27	56.98	62.20	60.90	60.10	58.30
Chemical characteristics									
pH (wet)	4.8	5.6	6.3	6.4	6.3	5.6	5.9	5.4	5.9
pH (dry)	4.1	4.3	4.2	4.6	4.2	4.3	4.4	4.6	3,9
pH (KCl)	3.2	3.3	3.4	4.0	3.3	3.7	3.6	3.5	3.5
EC dSm^{-1}	-	-	-	-	-	-	-	-	-
o.c%	0.287	0.075	0.562	1.437	0.075	0.188	0.188	0.237	0.05
o.m%	0.493	0.129	0.966	2.47	0.129	0.323	0.323	0.407	0.086
CEC $cmol(+)\ kg^{-1}$	14.5	15.2	17.3	18.0	14.8	13.0	13.2	14.5	12.8
Exch.H $me\ 100g^{-1}$	0.24	0.32	0.24	0.16	0.16	0.18	0.24	0.24	0.16
Exch.Al $me\ 100g^{-1}$	0.64	0.40	0.32	0.16	0.16	0.32	0.16	0.32	0.88
Total N%	0.336	0.308	0.476	0.560	0.280	0.252	0.204	0.280	0.280
Total P%	0.046	0.062	0.046	0.047	0.051	0.043	0.073	0.043	0.045
Total K%	0.200	0.11	0.260	0.980	0.200	0.240	0.380	0.240	0.220

Ap2: 10 - 25 cm. Olive 5Y 5/3 (moist) and brown 10 YR 5/3 (dry), clayey, massive, slightly sticky, cemented with clay, many micro pores, very few fibrous roots, clear boundary pH 5.6 (wet) and 4.3 (dry).

C1: 25 - 47 cm. Dark greyish brown 2.5 Y 4/2 (moist) and light olive brown 2.5 Y 5/4 (dry), clayey, massive, sticky, cemented with clay, diffused boundary. pH 6.3 (wet), and 4.25 (dry).

C2: 47 - 100 cm. Dark greyish brown 2.5 Y 4/2 (moist) and dark brown 10 YR 3/5 (dry), clayey, massive, sticky, cemented with clay, pH 6.4 (wet) and 4.6 (dry).

Pedon 4

Profile description

Ap1: 0-11 cm, Olive 5Y 4/3 (moist) and brown 10 YR 5/3 (dry), presence of brownish mottlings, sandy clay loam, fine granular, slightly sticky, cemented with clay, presence of macro and micro pores, many fibrous roots, clear wavy boundary. pH 4.1 (wet), 3.4 (dry).

Table 9. Physico - chemical characteristics of pedon 4

Physical characteristics	Surface samples								
	AP1	AP2	C1	C2	1	2	3	4	5
Texture	Sandy clay loam	Sandy clay	Sandy clay loam	Sandy loam	Sandy clay loam	Sandy loam clay	Sandy clay loam	Sandy clay	Sandy Clay
% C.S	46.4	42.5	53.8	69.8	51.2	43.7	52.5	39.8	40.2
% F.S	9.4	8.0	9.6	10.2	10.2	9.2	9.7	8.4	10.7
% Silt	15.0	20.0	15.0	7.0	12.0	15.0	12.0	10.0	8.0
% Clay	35.0	40.0	32.0	15.0	30.0	34.0	26.0	44.0	45.0
B.D	1.22	1.01	1.40	1.40	1.29	1.07	1.14	1.36	1.35
P.D	2.25	1.97	2.09	2.44	2.40	2.08	2.24	2.36	2.40
Porosity	49.72	51.88	51.88	48.17	48.35	55.81	59.67	44.38	47.08
Chemical characteristics									
pH (wet)	4.1	4.4	5.1	4.9	5.7	6.3	5.5	5.8	6.4
pH (dry)	3.5	3.9	3.3	2.8	3.4	3.9	3.5	4.1	4.2
pH (KCl)	2.9	2.6	3.0	2.5	3.0	3.2	3.2	3.0	3.0
EC dSm^{-1}	–	–	–	–	–	–	–	–	–
O.C%	1.47	2.02	1.01	1.65	1.53	2.23	1.98	0.35	0.40
O.M%	2.51	3.45	1.73	2.82	2.67	3.81	3.39	0.59	0.68
CEC $cmol(+)kg^{-1}$	14.4	15.8	15.0	12.9	14.9	15.6	16.8	15.2	11.7
Exch.H $me\ 100g^{-1}$	3.84	6.80	3.12	0.16	0.16	0.16	0.32	0.24	0.32
Exch.Al $me\ 100g^{-1}$	0.64	0.40	0.80	0.32	0.32	0.16	0.24	0.24	0.16
Total N%	0.204	0.308	0.392	0.560	0.280	0.252	0.308	0.336	0.252
Total P%	0.042	0.031	0.021	0.026	0.028	0.025	0.037	0.027	0.020
Total K%	0.22	0.36	0.16	0.12	0.18	0.44	0.40	0.12	0.20

Ap2: 11 - 30 cm. Dark greyish brown 2.5 Y 4/2 (moist) and yellowish brown 10 YR 5/4 (dry), presence of brownish mottlings, sandy clay, massive, sticky, cemented with clay, more micro pores than macro, fewer roots, clear boundary. pH 4.4 (wet), 3.9 (dry).

C1: 30 - 41 cm. Dark greyish brown 2.5 Y 4/2 (moist) and yellowish brown 10 YR 5/4 (dry), mottlings nil, sandy clay loam, granular, non sticky, cemented with clay, macro pores abundant, very few roots, clear boundary. pH 5.1 (wet), 3,3 (dry).

C2: 41 - 100 cm. Dark greyish brown 10 YR 4/2 (moist) and light grey 10 YR 5/2 (dry), no mottlings, sandy loam, granular, nonsticky, no cementation, micro pores more. pH 4.9 (wet) 2.7 (dry).

Pedon 5

Profile description

Ap1: 0-8 cm. Brown 10 YR 5/3 (dry) and dark brown 10 YR 3/3 (moist) sandy clay, fine granular, slightly sticky, cementation with clay, macro and micro pores, many

Table 10. Physico - chemical characteristics of pedon 5

Physical characteristics	Surface samples								
	AP1	AP2	C1	C2	1	2	3	4	5
Texture	Sandy clay	Clay	Clay	Clay	Clay	Clay	Clay	Clay	Clay
% C.S	41.3	20.2	4.3	2.7	12.6	15.3	10.6	17.2	10.4
% F.S	8.4	6.1	3.7	1.1	7.2	6.9	4.3	6.5	3.7
% Silt	10.0	9	10	14	7	6	3.0	7.0	6.0
% Clay	40.0	66	80	85	76	70	80	72	85
B.D $g.cc^{-1}$	1.16	1.07	1.09	1.22	1.29	1.44	1.17	1.20	1.18
P.D $g.cc^{-1}$	1.97	2.04	2.36	2.31	2.21	2.41	2.16	2.18	2.26
Porosity%	37.01	48.37	51.47	51.31	44.09	41.3	49.42	46.69	50.74
Chemical characteristics									
pH (wet)	6.0	5.8	6.3	6.4	6.0	6.2	5.9	6.3	5.7
pH (dry)	3.8	3.3	3.9	3.8	4.1	3.8	3.9	4.2	4.2
pH (KCl)	3.3	3.1	3.4	3.4	3.4	3.5	3.4	3.3	3.2
EC dSm^{-1}	–	–	–	–	–	–	–	–	–
o.c%	1.185	2.160	2.790	2.895	1.995	1.77	1.41	1.065	1.725
o.m%	2.02	3.69	4.77	4.95	3.41	3.03	2.41	1.82	2.95
CEC cmol (+) kg^{-1}	12.5	13.5	17.7	18.1	15.5	12.6	16.2	15.3	13.9
Exch.H me 100 g^{-1}	0.24	0.32	0.32	0.40	0.24	0.32	0.32	0.18	0.32
Exch.Al me 100 g^{-1}	0.16	0.56	0.24	0.32	0.32	0.48	0.32	0.32	0.40
Total N%	0.196	0.336	0.448	0.476	0.207	0.280	0.196	0.280	0.252
Total P%	0.038	0.035	0.031	0.036	0.038	0.042	0.035	0.028	0.038
Total K%	0.24	0.32	0.34	0.28	0.26	0.26	0.28	0.20	0.30

fibrous roots, wavy, clear and sharp boundary. pH 6.0 (wet); 3.9 (dry).

Ap2: 8-26 cm. Olive 5Y 5/3 (dry) and brown 10 YR 5/3 (moist) Clayey, fine granular, sticky when wet, cemented with clay, more micro pores than macro pores, lesser number of fibrous roots, diffusing boundary. pH. 5.8 (wet), 3.3 (dry).

C1: 26 - 61 cm. Dark brown 10 YR 3/3 (dry) and greyish brown 2.5 Y/2 (moist) clayey, massive, sticky, when wet, cemented with clay, diffused boundary. pH. 6.3 (wet), 3.9 (dry).

C2: 61-100 cm. Dark brown 10 YR 3/3 (dry) and dark greyish brown 2.5 Y 4/2 (moist) clayey, massive, sticky when wet, cemented with clay. pH. 6.4 (wet), 3.8 (dry).

Pedon 6

Location: 8^{O} 26'3" N latitude, 76^{O} 49'5"E longitude. 200m NE of the stone wall.

Information on the site

Below 0.5m MSL. Valley bottom. Garden lands (reclaimed kayal lands), surrounded by gently undulating hillocks. Undulating topography. Slope less than 1^{o}. Main crop coconut, along with banana and other trees. Isohyperthermic temperature regime.

Information on the soil

Cumelic anthrosols surface soil dry, 85 cm onwards wet, depth of ground water 70 cm cultivated for last 20 years.

Profile description

Ap1: 0-15 cm. Yellowish brown 10 YR 5/4 (dry) and dark yellowish brown 10 YR 4/4 (moist) sandy clay loam, coarse granular structure, non sticky when wet and friable when moist, weak cementation, macro pores more many roots, diffusing boundary, pH 4.0 (dry).

Table 11. Physico - chemical characteristics of pedon 6

Physical characteristics	Surface samples								
	AP1	AP2	C1	C2	1	2	3	4	5
Texture	Sandy clay loam	Sandy clay loam	Sandy clay	Sandy clay	Sandy clay loam	Sandy clay	Sandy clay loam	Sandy clay	Sandy Clay
% C.S	58.5	64.8	44.2	41.8	63.5	38.6	66.9	48.8	43.0
% F.S	4.9	6.7	4.7	6.6	8.5	10.2	11.2	9.0	9.0
% Silt	8.0	6.0	7.0	3.0	2.0	2.0	3.0	4.0	3.0
% Clay	32.0	29.0	50.0	48.0	30.0	48.0	21.0	40.0	46.0
B.D $g.cc^{-1}$	1.47	1.23	1.46	1.44	1.34	1.38	1.39	1.46	1.44
P.D $g.cc^{-1}$	2.32	1.91	2.29	2.40	2.12	2.26	2.28	2.32	3.46
%Porosity	38.61	39.55	39.34	41.10	40.52	42.03	43.09	38.99	40.65
Chemical characteristics									
pH (dry)	3.83	4.3	3.8	3.8	4.2	3.9	4.1	4.1	4.2
pH (KCl)	3.2	3.4	3.3	3.2	3.3	3.4	3.4	3.2	3.5
EC dSm^{-1}	-	-	-	-	-	-	-	-	-
o.c%	1.684	0.678	0.246	0.354	0.847	0.569	0.785	0.816	0.569
o.m%	2.88	1.16	0.421	0.61	1.45	0.974	1.34	1.39	0.974
CEC $cmol(+)kg^{-1}$	12.5	11.8	10.7	11.6	13.3	12.0	13.8	12.0	12.5
Exch.H me $100g^{-1}$	0.32	0.34	0.04	0.24	0.24	0.08	0.32	0.16	0.16
Exch.Al me $100g^{-1}$	0.40	0.16	0.32	0.40	1.36	0.80	1.36	0.88	0.24
Total N%	0.168	0.168	0.140	0.140	0.196	0.204	0.168	0.252	0.280
Total P%	0.026	0.031	0.021	0.037	0.042	0.048	0.068	0.052	0.043
Total K%	0.26	0.14	0.22	0.18	0.24	0.28	0.40	0.22	0.26

Ap2: 15 - 29 cm. Pale brown 10 YR 6/3 (dry) and dark greyish brown 10 YR 4/3, sandy clay loam, fine granular, slightly sticky when wet, friable when moist, weak cementation, both macro and micro pores, no carbonates/salts, many roots, clear boundary. pH. 4.3 (dry).

C1: 29 - 67 cm. pale brwon 10 YR 6/3 (dry) and 10 YR 4/2 (moist), no mottlings, sandy, coarse, non sticky when wet, friable when moist, no cementation, macro pores more, no carbonates/salts, nd roots, clear boundary. pH 3.8 (dry).

C2: 67 - 100 cm. 10 YR 6/4 (dry) and dark greyish brown 10 YR 5/3 (moist), slight reddish mottlings, clay loam, fine granular, slightly sticky when wet, sticky when moist, more micro pores, no carbonates/salts. pH. 3.8 (dry).

Pedon 7

Loation: 8^{O} 26'3" N latitude and 76^{O} 49' 5"E longitude Vellayani. 70 m west of the road.

Information on the site

Valley bottom garden lands (reclaimed kayal land) surrounded by gently undulating hillocks. Level land with bunds and ridges, slope less than 1^{o} main crop banana. Isohyperthermic temperature regime.

Information on the soil

Cumelic anthrosol Surface soil dry. 60 cm onwards wet. Depth of water table 70 cm, No evidence of erosion, no salts or alkalies, cultivated for last ten years with banana.

Profile description

Ap1: 0-8 cm. Pale brown 10 YR 6/3 (dry) and brown 10 YR 4/3 (moist), no mottling, sandy clay loam, fine granular, slightly sticky when wet soft when moist, friable when dry, weakly cemented, both macro and micro pores present, many roots diffused boundary. pH 4.7 (dry)

Table 12. Physico-chemical characteristics of pedon 7

Physical characteristics	Surface samples								
	AP1	AP2	C1	C2	1	2	3	4	5
Texture	Sandy clay loam	Sandy clay loam	Sandy clay	Clay	Sandy clay	Sandy clay	Sandy clay	Clay loam	Sandy clay
% C.S	47.2	49.2	42.3	28.9	39.4	48.2	41.7	38.9	44.6
% F.S	9.4	13.4	10.5	9.5	10.2	11.3	8.7	6.4	10.6
% Silt	12.0	18.0	10.0	11.0	7.0	6.0	8.0	7.0	8.0
% clay	33.0	30.0	40.0	57.0	47.0	50.0	51.0	48.0	47.0
B.D gcc^{-1}	1.32	1.04	1.30	1.18	1.25	1.33	1.26	1.15	1.22
P.D gcc^{-1}	2.43	1.83	2.33	2.48	2.16	2.25	2.44	2.32	2.43
Porosity%	52.05	48.97	52.22	55.63	44.65	45.64	54.58	53.99	55.41
Chemical Characteristics									
pH (dry)	4.7	4.2	4.0	4.2	4.1	4.2	4.3	4.2	4.0
pH (KCl)	3.6	3.5	3.1	3.4	3.7	3.6	3.5	3.6	3.7
EC dSm^{-1}	–	–	–	–	–	–	–	–	–
o.c%	1.2	1.17	1.06	1.87	0.862	1.58	1.40	1.40	1.34
o.m%	2.05	2.00	1.81	3.20	1.48	2.70	2.39	2.39	2 29
CEC $cmol(+)\ kg^{-1}$	14.5	13.2	12.4	15.3	12.8	13.5	13.5	12.0	12.8
Exch.Al me. $100g^{-1}$	0.24	0.40	0.48	0.24	0.16	0.08	0.16	0.08	0.16
Total N%	0.196	0.168	0.196	0.196	0.280	0.204	0.204	0.196	0.252
Total P%	0.058	0.046	0.050	0.060	0.046	0.063	0.056	0.07	0.067
Total K%	0.24	0.14	0.14	0.20	0.32	0.28	0.22	0.26	0.24

Ap2: 8-20 cm. Pale brown 10 YR 6/3(dry) and dark greyish brown 10 YR 4/2 (moist), sandy clay loam, fine granular, slightly sticky when wet, soft when dry, cemented with clay, both macro and micro pores, few roots, clear boundary pH 4.2 (dry).

C1: 20-40 cm. Brown 10 YR 5/3 (dry) and dark yellowish brown 10 YR 3/4 (moist), few brown mottlings, sandy clay, massive, sticky when wet, cemented with clay,micro pores more, diffused boundary. pH 4.0(dry)

C2: 40-100 cms, few reddish brown mottlings, clay, massive sticky when wet, hard when dry, cemented with clay, micro pores more. pH 4.2 (dry).

Pedon 8

Location : 8^{O} 26' 3" M latitude and 76^{O} 49'5" E longitude. Vellayani. Western side of College building. 100m west from the tank and 15 m south of the bund.

Information on the site

Below 0.5 m MSL Valley bottom kayal lands. Now reclaimed garden land. Occasional flooding. Level topography with bunds prepared for paddy field. Cultivated with paddy. Isohyperthermic temperature and aquic moisture regime,

Information on the soil

Cumelic anthrosol, Surface soil moist. 70 cm onwards wet. Depth of water table 70 cm, No evidence of erosion, no salts or alkalies, cultivated with rice.

Profile description

Ap1: 0-8 cm. Light yellowish brown 10 YR 6/4 (dry) and dark yellowish brown 10YR 4/4 (moist). sandy loam, fine granular, non sticky when wet, friable when moist and soft when dry, weak cementation, more maco pores, many fibrous roots, clear boundary. pH 4.2 (dry).

Ap2: 8-20 cm. Brown 10 YR 5/3 (dry) and very dark greyish brown 2.5 Y 3/2 (moist), sandy clay loam, fine granular, slightly sticky when wet, friable when moist and soft when dry, weak cementation, few macro and many micropores, many fibrous roots , clear boundary. pH 4.4 (dry).

Ap3: 20-54 cm. Olive yellow 2.5 Y 6/6 (dry) and olive brown 2.5 Y 5/4 (moist). Slight reddish mottlings, sandy clay, fine granular, slighly sticky when wet, friable when moist and hard when dry, cemented with clay, micro pores more, very few roots diffused boundary. pH 4.5 (dry).

C1: 54-70 cm. Brown 10 YR 5/4 (dry) and dark brown 10 YR 4/4 (moist), Reddish mottlings, clayey, massive, sticky when wet and moist, hard when dry, cemented with clay, micro pores more, clear boundary, pH 4.0 (dry)

C2: 70-100 cm. Yellowish brown 10 YR 6/6 (dry) and dark brown, 10 YR 5/6 (moist). clayey, massive, sticky when wet, hard when dry, cemetation with clay, more micropores. pH 4.5 (dry).

Table 13. Physico-chemical characteristics of pedon 8

Physical characteristics						Surface samples				
	AP1	AP2	AP3	C1	C2	1	2	3	4	5
Texture	Sandy loam	Sandy clay loam	Sandy clay	Clay	Clay	Sandy clay loam	Sandy clay loam	Clay clay loam	Sandy clay loam	Sandy clay loam
% C.S	68	65	44.2	19.6	20.1	58.1	50.7	52.3	60.2	55.7
% F.S	13.4	11.3	11.1	17.9	10.6	12.4	11.5	9.4	13.2	10.3
% Silt	6.0	3.0	3.0	9.0	7.0	3.0	5.0	5.0	4.0	3.0
% Clay	20.0	23.0	43.0	56.0	64.0	28.0	35.0	33.0	22.0	32.0
BD $g.cc^{-1}$	1.2	1.15	1.60	1.26	1.09	1.24	1.30	1.33	1.32	1.31
PD $g.cc^{-1}$	2.18	1.90	2.31	2.34	1.98	2.13	2.35	2.26	2.26	2.30
Porosity%	43.26	42.51	38.35	48.3	47.17	44.61	46.36	44.86	45.61	45.09
Chemical characteristics										
pH (dry)	4.3	4.4	4.5	4.0	4.5	4.3	4.4	4.3	4.6	4.3
pH (KCl)	3.8	3.8	3.9	3.6	3.8	3.7	3.8	3.9	3.7	3.4
EC dSm^{-1}	–	–	–	–	–	–	–	–	–	–
o.c%	1.109	0.246	0.508	0.509	1.108	0.723	0.662	0.582	0.662	0.847
o.m%	1.89	0.421	0.809	0.974	1.890	1.237	1.133	0.996	1.133	1.450
CEC cmol(+) kg^{-1}	14.0	12.8	16.4	15.6	11.7	14.9	13.7	15.2	13.3	12.3
Exch.H me. $100g^{-1}$	0.16	0.16	0.16	0.24	0.16	0.08	0.16	0.24	0.16	0.16
Exch.Al me. $100g^{-1}$	0.08	0.24	0.08	0.16	0.32	0.08	0.08	0.16	0.16	0.32
Total N%	0.280	0.252	0.280	0.204	0.204	0.252	0.280	0.204	0.252	0.252
Total P%	0.063	0.042	0.026	0.018	0.037	0.050	0.042	0.051	0.056	0.046
Total K%	0.300	0.140	0.180	0.240	0.240	0.220	0.200	0.200	0.300	0.200

Pedon 9

Location: 8° 26' 3" M lattitude and 76° 49' 5" E longitude. Near Palappur.

Information on the site

Reclaimed kayal land , surrounded by undulating hillocks, level topography with bunds and ridges taken for vegetable cultivation. Isohyperthermic temperature regime.

Information on the soil

Surface soil dry 70 cm onwards wet. Depth of water table 70 cm, no evidence of erosion, no salts or alkalies, cultivated for last 10 years with vegetables.

Profile description

Ap1: 0-10 cm. Very dark brown 2.5 Y 3/2 (moist) and dark greyish brown 2.5 Y 7/2 (dry). No mottlings, sandy clay, non sticky and non plastic when wet, friable when moist and soft when dry, no cementation, macropores more, many roots, diffused boundry pH3.5 (dry).

Table 14. Physico-chemical characteristics of pedon 9

Physical characteristics	Surface samples							
	AP1	AP2	C1	1	2	3	4	5
Texture	Sandy clay	Sandy clay	Sandy clay loam	Sandy clay	Sandy clay	Sandy clay	Sandy clay	Sandy clay
% C.S	47.2	50.2	49.2	45.6	46.8	41.9	43.4	47.8
% F.S	9.3	10.3	9.0	8.7	7.3	6.5	7.7	9.8
% Silt	6.0	8.0	7.0	6.0	7.0	7.0	8.0	6.8
% clay	45.0	38.0	40.0	42.0	45.0	51.0	48.0	45.0
BD $g.cc^{-1}$	1.18	1.12	1.19	1.13	1.13	1.28	1.23	1.25
PD $g.cc^{-1}$	1.99	1.92	2.31	2.01	2.11	2.30	2.01	2.17
Porosity%	41.19	46.36	51.55	48.56	54.16	42.32	40.10	40.70
Chemical Characteristics								
pH (dry)	3.5	3.4	3.3	4.0	3.5	3.4	3.5	4.2
pH (KCl)	2.8	2.9	2.8	3.0	2.9	3.1	2.9	3.0
EC dSm^{-1}	-	-	-	-	-	-	-	-
OC%	2.06	2.0	1.11	2.06	1.9	0.7	1.31	1.13
o.m%	3.52	3.424	1.900	3.52	3.252	1.198	2.242	1.934
CEC $cmol(+)kg^{-1}$	16.2	17.9	10.2	16.4	15.8	16.3	17.5	14.9
Exch.H $me.100g^{-1}$	0.4	0.4	0.32	0.24	0.24	0.24	0.32	0.32
Exch.Al $me.100g^{-1}$	1.12	1.68	1.84	1.12	1.32	0.56	2.16	1.92
Total N%	0.280	0.252	0.280	0.336	0.308	0.252	0.280	0.252
Total P%	0.048	0.067	0.078	0.042	0.052	0.048	0.042	0.035
Total K%	0.280	0.200	0.280	0.260	0.280	0.220	0.340	0.260

Ap2: 10-20cm. Very dark brown 2.5 Y 3/2 (moist) and dark greyish brown 2.5 Y 7/2 (dry). Sandy clay, fine granular, slightly sticky and slightly plastic when wet, friable when moist and soft when dry. Weak cementation, both macro and micropores absent, few roots, diffused boundary pH 3.4(dry).

C1: 23-70 cm. Very dark brwon 2.5 Y 6/2 (moist) and dark greyish brown 2.5 Y 7/4 (dry). Clayey, massive, sticky and plastic when wet, hard when dry, cemented with clay, micro pores more. pH 3.3 (dry).

3. Water quality

3.1. pH

The lowest pH value was recorded during June. The water was slightly acidic during most part of the year except for December-January when the water was neutral with pH reaching up to 7.2 (Table 15).

Table 15. Fortnightly variation of pH of lake water (March 1993 to Feb. 1994)

Location	Mar 93		Apr 93		May 93		Jun 93		Jul 93		Aug 93		Sep 93		Oct 93		Nov 93		Dec 93		Jan 94		Feb 94	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
1	6.4	6.3	6.3	6.4	6.3	6.3	6.2	6.1	6.4	6.4	6.5	6.8	6.7	6.8	6.8	6.7	6.7	6.9	7.0	7.1	6.9	7.0	6.7	6.6
2	6.2	6.1	6.5	6.6	6.4	6.4	6.1	6.1	6.3	6.4	6.7	6.7	6.9	6.9	6.8	6.8	6.9	7.0	7.1	7.1	7.0	6.9	6.8	6.7
3	6.3	6.3	6.4	6.5	6.4	6.4	6.0	5.9	6.3	6.5	6.4	6.6	6.8	6.7	6.9	6.8	6.8	7.1	7.0	6.9	6.9	6.9	6.7	6.7
4	6.3	6.3	6.2	6.4	6.5	6.3	6.0	6.2	6.4	6.3	6.6	6.5	6.7	6.7	6.7	6.7	6.9	6.9	6.9	6.9	6.8	7.0	6.7	6.6
5	6.4	6.4	6.3	6.4	6.4	6.5	6.1	6.0	6.1	6.4	6.6	6.6	6.5	6.7	6.8	6.9	7.0	7.0	7.1	7.2	6.9	6.8	6.8	6.6

Table 16. Fortnightly variation of pH of soil (March 1993 to February 1994)

Location	Mar 93		Apr 93		May 93		Jun 93		Jul 93		Aug 93		Sep 93		Oct 93		Nov 93		Dec 93		Jan 94		Feb 94	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
1	5.7	5.6	5.4	6.1	6.05	5.9	5.3	5.4	5.3	5.7	5.8	6.0	6.0	6.1	5.9	5.7	6.0	5.8	5.9	6.0	5.6	5.7	5.5	5.6
2	5.9	5.8	5.5	5.7	5.08	5.1	6.0	5.7	5.4	5.3	5.4	5.9	6.0	6.0	6.2	5.9	6.1	6.0	6.0	5.8	5.9	5.6	5.7	5.7
3	5.4	5.1	4.9	6.2	6.1	5.7	5.8	5.6	5.4	5.5	5.4	5.5	5.9	6.0	6.0	5.7	5.9	5.9	5.8	5.7	5.4	5.6	5.5	5.7
4	5.1	5.3	5.4	5.5	6.2	6.0	5.5	5.7	5.7	5.9	5.7	5.9	6.8	5.9	5.7	5.8	6.1	6.1	5.7	5.6	5.7	5.9	5.4	5.6
5	5.6	5.6	5.5	5.5	6.3	5.9	5.8	5.6	5.1	5.0	5.9	5.8	6.0	5.8	5.7	5.9	6.0	6.1	6.0	5.9	5.7	5.5	5.6	5.5

3.2 Conductivity / salinity

The salinity level of the water samples collected during any part of the year did not reach a level that could be measured. The values remained below 0.05 dS m^{-1}.

3.3 Chloride

The chloride content of the water samples were quite low during most part of the year. The highest value obtained was 3.0 ppm approximately and was recorded during December. During March samples obtained from all the stations were chloride free (Table 17).

3.4 Sulphate

Sulphate values were too low to be analysed and recorded during any part of the year

4. Periodical Variation of pH, salinity, chloride, sulphate in soil samples

4.1 pH

The soil was slightly acidic in all months. Lowest value was recorded during February - March and pH was high during September - October (Table 16).

Table 17. Fortnightly variation of chloride in water (ppm)

Location	Mar 93		Apr 93		May 93		Jun 93		Jul 93		Aug 93		Sep 93		Oct 93		Nov 93		Dec 93		Jan 94		Feb 94	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
1	-	-	-	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	-	2.0	1.0	2.0	1.0	1.0	-	2.0	1.0	1.0	-	1.0	1.0
2	-	-	1.0	-	1.0	-	1.0	1.0	2.0	1.0	2.0	2.0	2.0	1.0	1.0	1.0	2.0	2.0	2.0	1.0	1.0	1.0	-	1.0
3	-	-	-	-	1.0	1.0	-	1.0	1.0	2.0	2.0	1.0	-	1.0	1.0	2.0	2.0	1.0	3.0	2.0	2.0	1.0	-	-
4	-	-	1.0	1.0	-	1.0	1.0	-	1.0	-	1.0	2.0	1.0	-	1.0	1.0	2.0	2.0	2.0	2.0	2.0	2.0	1.0	-
5	-	-	-	-	-	1.0	1.0	1.0	1.0	-	1.0	-	-	-	1.0	2.0	3.0	2.0	2.0	1.0	1.0	1.0	1.0	1.0

Table 18. Fortnightly variation of chloride in soil (ppm)

Location	Mar 93		Apr 93		May 93		Jun 93		Jul 93		Aug 93		Sep 93		Oct 93		Nov 93		Dec 93		Jan 94		Feb 94	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
1	2.0	2.0	3.0	2.0	4.0	4.0	3.0	3.0	3.0	4.0	3.0	4.0	4.0	4.0	5.0	6.0	4.0	5.0	6.0	5.0	5.0	4.0	4.0	4.0
2	3.0	2.0	2.0	3.0	4.0	3.0	4.0	3.0	4.0	4.0	4.0	3.0	4.0	4.0	6.0	6.0	5.0	5.0	7.0	6.0	5.0	5.0	4.0	4.0
3	2.0	4.0	3.0	3.0	4.0	4.0	3.0	3.0	4.0	5.0	4.0	3.0	5.0	4.0	6.0	5.0	5.0	5.0	7.0	6.0	7.0	5.0	5.0	4.0
4	4.0	2.0	4.0	3.0	3.0	2.0	2.0	4.0	3.0	4.0	5.0	4.0	5.0	4.0	4.0	6.0	5.0	4.0	6.0	7.0	6.0	7.0	5.0	4.0
5	2.0	3.0	3.0	4.0	4.0	4.0	3.0	3.0	4.0	3.0	5.0	5.0	5.0	5.0	6.0	6.0	6.0	5.0	7.0	6.0	5.0	5.0	6.0	5.0

4.2 Salinity

As in the water samples, soil samples also did not show any presence of salt during any part of the year.

4.3 Chloride

Chloride content was higher when compared to water samples collected from the same location. November - December recorded values as high as 7 ppm while March- April recorded low values (Table 18).

4.4 Sulphate

As in water samples, sulphate content of soil sample was too low to be analysed.

5. Bathymetry

The depth of the lake was measured during December when the lake was full. The lake has a maximum depth of 3 metres. The lake becomes progressively shallow towards the banks. It has a depth of only 1 m near the banks. There is a

channel along the length of the lake right from the reservoir to Muttackad. The depth in this channel was 2 m.

The resorvoir has almost uniform depth. The maximum depth is at the centre where it is 1.8m depth (Map 1).

6. Land use

Cocunut is the dominant crop in the reclaimed land as well as the garden lands., Paddy is cultivated in a limited scale in the northern end, near the resorvoir and at the southern end. Paddy is cultivated in the Kayal lands after dewatering, except for the deepest area where water is not drained.

Mixed trees which include Mango, jack, arecanut, are also seen associated with homesteads Banana is also cultivated as intercrop with coconut. In addition, Banana is cultivated as pure crop in raclaimed areas.

Other major crops are tapioca and mixed crop which include papaya, clove, vegetables , other herbs and shrubs.

The College of Agriculture campus occupies 75 ha in western end of the Kayal and houses the various buildings of the college and other crops. An overview of the present land use is presented in the land use map (Map 2).

7. Soil fertility status

Available nitrogen was found to be high in all the profile sites except at Muttakad (profile no. 3) and at the rice growing area near the college campus. At Muttakkad, the available nitrogen content was low and at the rice growing area near the college available nitrogen content was medium.

The available phosphorus content was high in all the profile sites.

Available potassium content was high at Muttakad and at Punchakkari (profile no 5). It was low at coconut grown area. In all the other sites, the available potassium content was medium. The fertility status of the lake and the adjoining areas is presented in the fertility map (Map 3).

8. Reduction in lake area

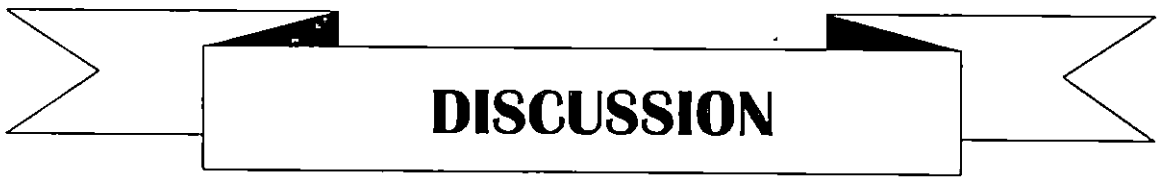
The comparison of maps of 1927 and 1991 showed that 60% of the original lake area has been reclaimed. In 1927 the area of the lake was 650 ha whereas it reduced to 224 ha in 1991. (Map 4)

9. Flora and Fauna

Common wet land weeds flourish in the lake bottom when the lake is dewatered. The commonly found weeds are Monochoria vaginalis. Echinocloa colonum, E. crusgalli, Panicum sp., Marsilia sp., Cyperus sp.

The lake is an abode of a variety of fresh water fishes and pawns. The most common fish variety found in the lake is Etroplus sp., common carp etc.

Fresh water prawns are also found in large numbers in the lake. The common species found in the lake are Palaemon and Macrobachium sp.

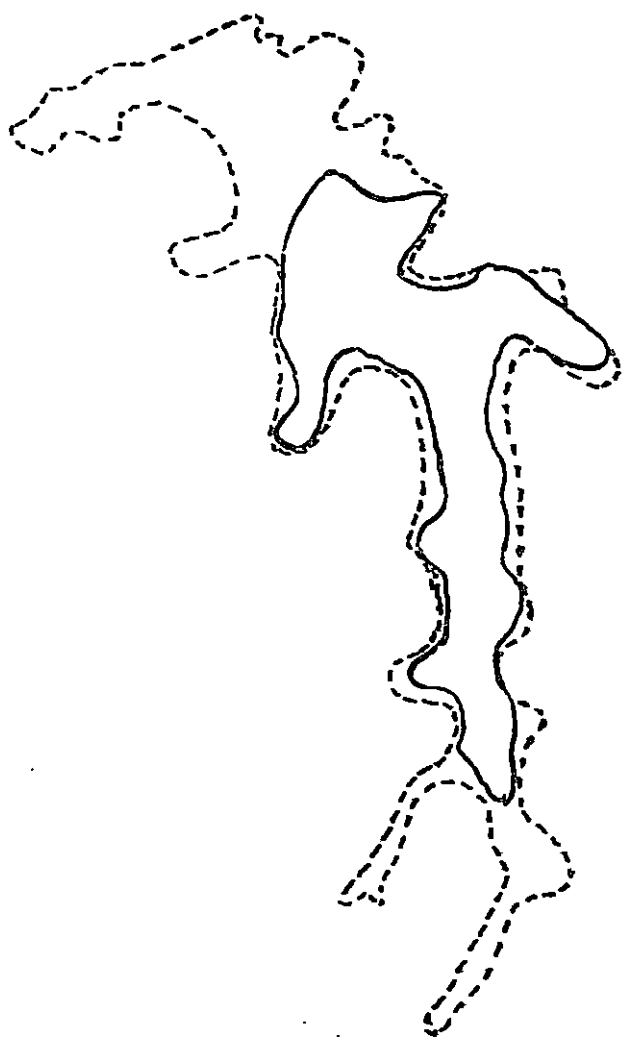

DISCUSSION

MAP.4. DIMINUTION OF THE LAKE (1926-1991)

SCALE 1:50,000

— — Lake boundary (1926)

——— Lake boundary (1991)



Source:

Survey of India Map — —

NRSA ———

DISCUSSION

Climate and Environment

A perusal of the data on climatic parameters and related environmental factors lead us to very valid conclusions regarding their impact on the ecosystem of Vellayani lake.

Being a natural fresh water lake evolved in a remote geological past, with specific geomorphology and climate, the lake relies on the climate for its survival to a large extent. The location of Vellayani lake is in a region with isohyperthermic temperature regime and ustic moisture regime.

Data on temperature does not show much variation over a period of 11 years (1983-'93) as well between different months, indicating its isohyperthermic regime. An analysis of the annual precipitation from a data of over 50 (1943-'93) years indicates a mean annual precipitation of 1840 mm. However, data of the recent past for a period of 11 years shows a drastic decline in average annual precipitation bringing the figure to 1520 mm (Fig. 1).

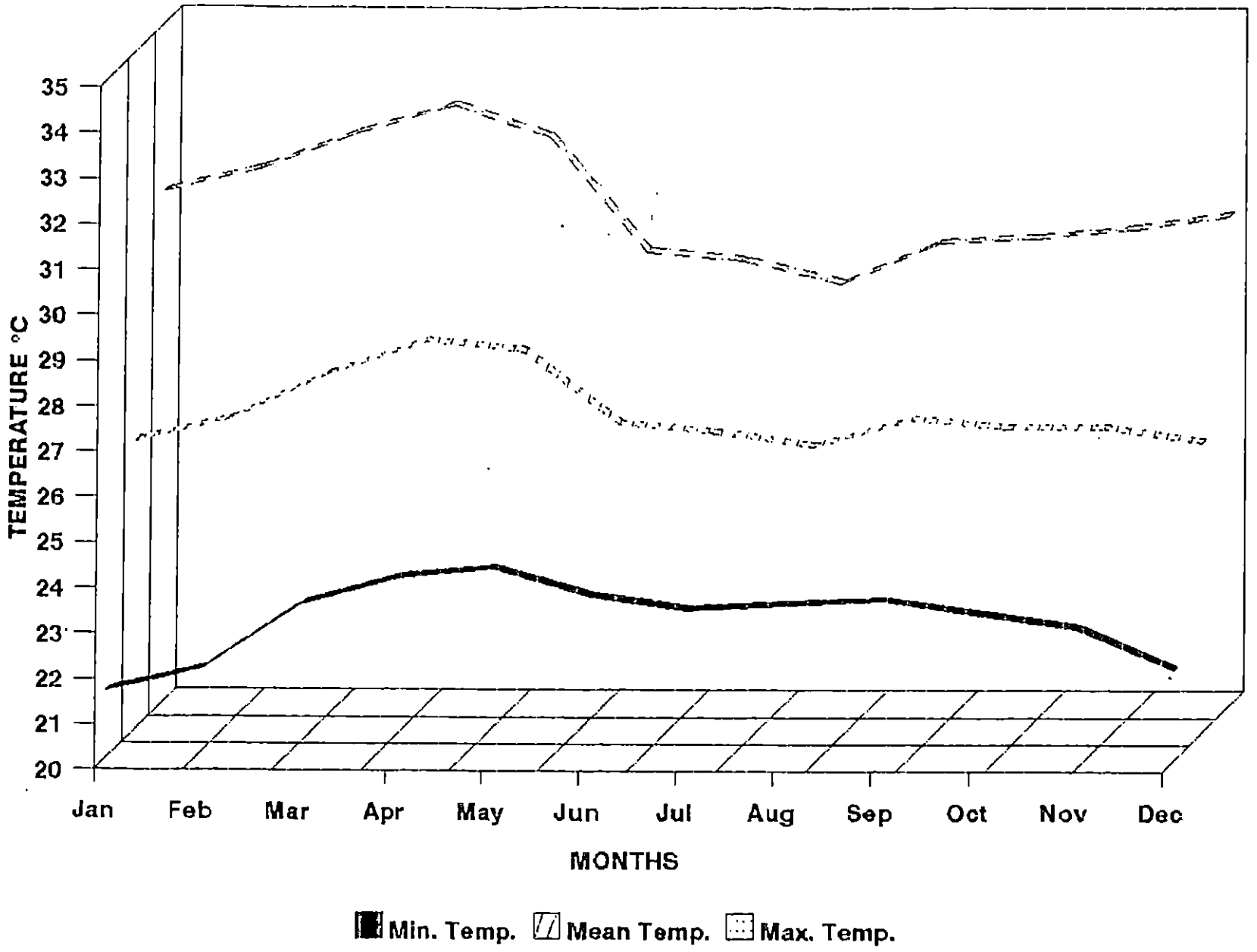


Fig. 1. Monthly variation in ambient temperature (mean values for 11 years)

Monthly variation in precipitation shows two classical peaks (Fig. 2), viz. June and Oct-Nov. December to April is the drought period in the region, of which the months January and February are the driest ones with a mean monthly rainfall below 20 mm. The changeover of the past 11 year data from that of the last five decades is evident in the monthly distribution of rainfall also (Fig. 3).

The data on evapotranspiration gives an annual value of 1688 mm which is at present higher than that of the mean annual precipitation of the last 11 years. The decline in the annual precipitation and the erratic distribution of the same are of great significance in maintaining water availability of the Vellayani lake ecosystem as well the adjoining areas. It may be seen that the moisture deficit of this region is of recent origin due to the decline in rainfall. This change in climate is to be taken into cognisance because of the change in water availability for crops as well for drinking purpose. With the decline in rainfall and an increase in ET, there is every possibility for the already deep ground water table in the adjoining uplands and hillocks to go still deeper. Any

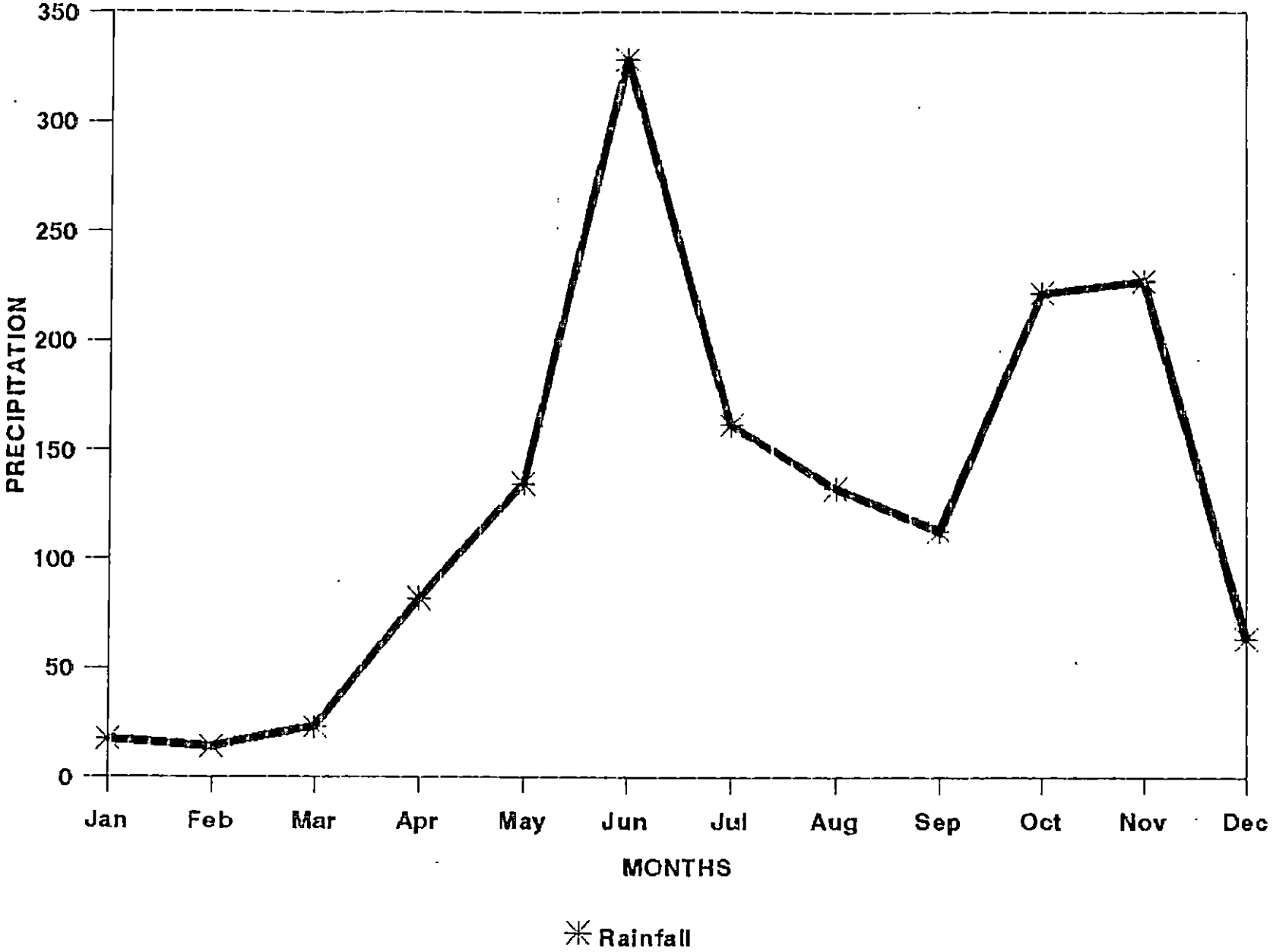
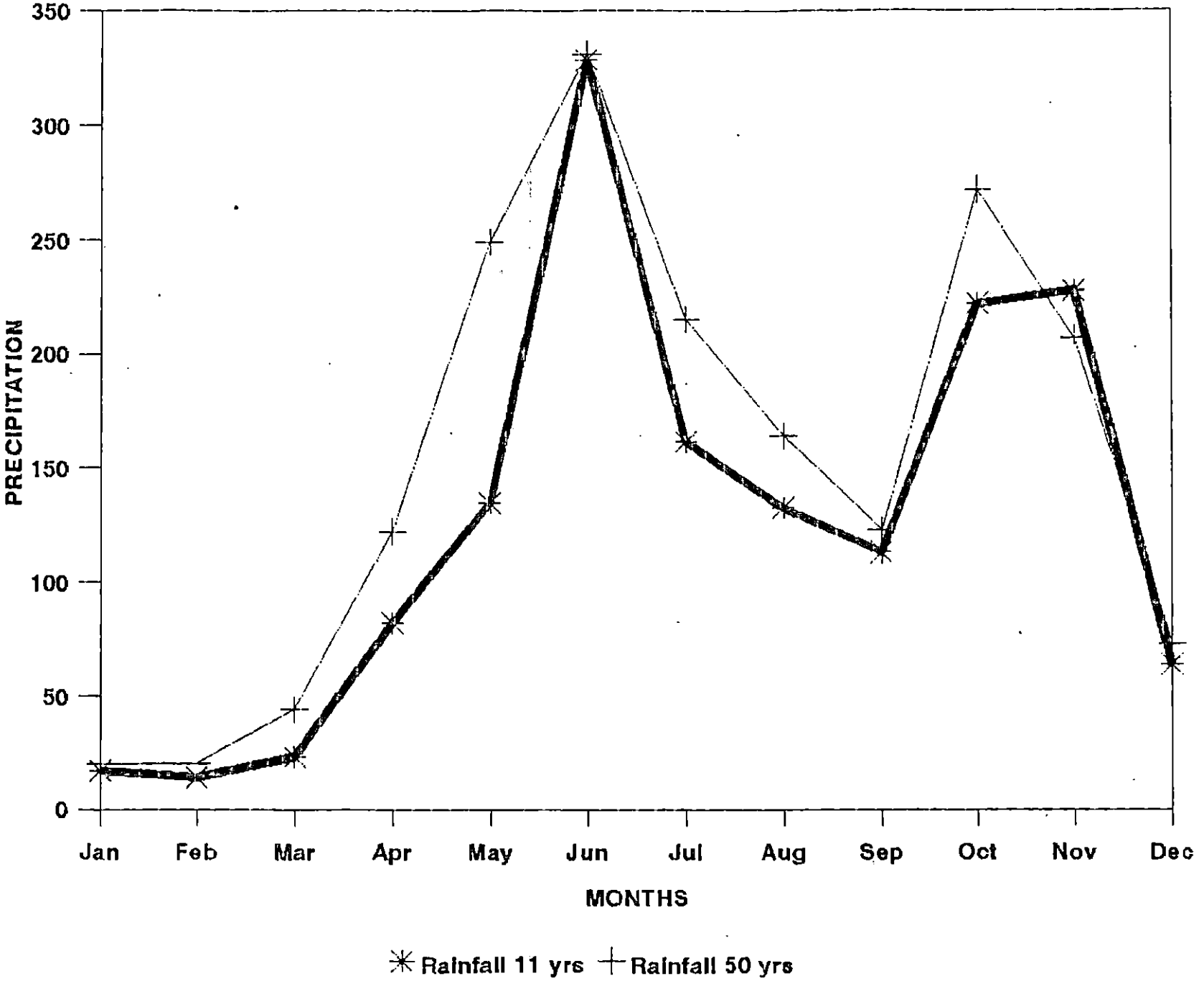


Fig. 2. Monthly variation of precipitation (mean values for 11 years)


350
300
250
200
150
100
50
0
PRECIPITATION
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
MONTHS
Rainfall 11 yrs
Rainfall 50 yrs

activity that will reduce the impounded water in the lake will aggravate the drought condition during the period, December to May.

Pedological aspects of lake bottom soil profiles

Pedon Nos 1 to 5, were identified from Vellayani lake bottom after artificial drainage.

In all the pedons collected from the bottom, the morphological features were almost the same. The colour of the soil became darker as the depth increased. This was evident from the lower value and chroma of the deeper horizons. The darker colour of the lower horizon can be attributed to the high organic matter content.

Analysis of physical characteristics revealed that the clay content increases with depth in all the pedons except Pedon 4. In Pedon 4, the lower layers were sandy clay loam and sandy loam, whereas the upper layers contained more clay. In all the other 4 pedons, sand fraction dominated the upper horizon. The clay content of a soil is well reflected in its physical property also. The bulk density and particle

density decreases with depth except in pedon 4 where bulk density is seen increasing with depth. All the soils low high percentage porosity. This variation in Pedon 4 may be attributes to the differential sedimentation in that area.

The pH of the wet samples increased with depth in each pedon. The pH of the soil was acidic in all the profile. Drying of the soil reduced the pH making the soil more acidic. The KCl pH was still lower. The KCl pH also increased with depth in each pedon. The soils were free from salts of any kind. So no conductivity was obtained for any of the samples.

The organic carbon content of the soil increased with depth in each pedon. This can be due to the accumulation and sedimentation of organic matter for the past several years. The highest organic carbon content was obtained in the lower most layer of the Pedon I.

CEC showed a direct relationship with organic matter content. CEC increased with depth in all the pedons. The mean CEC values were 16.12, 16.1, 16.25, 14.5 and 15.5 for pedon 1, 2, 3, 4 and 5 respectively. The increase in CEC

with depth in each pedon can be attributed to the increasing clay content also, except for pedon 4 where clay content was found decreasing. Here, the CEC was also lower than the upper horizon. The exchangeable hydrogen and aluminium had low values for all samples showing that non of the pedons were potentially nor actively acidic soils.

The total nitrogen values increased with increase in depth in each pedon. This must be due to the increase in the organic matter content of the soil. The total phosphorus content did not show any particular pattern but it did not show much variation within a pedon. The total K content was lower in the 1st horizon of all pedons but it increased in the next layer and then decreased. This was true for all the pedons.

All the pedons taken from the lake bottom did not show the presence of a B horizon. The characteristic features of the pedons indicate their recent origin on fluvial sedimentary materials in a lagoon which is naturally water logged, resulting in the formation of a wet land marsh. Cultivation is possible only by artificial drainage. There is no evidence of classical profile development or any

characteristic diagnostic surface or subsurface horizon. Hence the soil can be included under Entisol.

The soil characteristics investigated in the present study indicated that the lake is a highly productive soil system which can be utilised for aquaculture rather than agriculture considering other ecological and environmental factors.

Impact of different land use on pedon characteristics

Pedon nos. 6-9 represent reclaimed area under different land use and other human influence.

Pedon 6 represents the eastern side of the lake, on the reclaimed lands now under coconut cultivation.

Morphological examination of the samples of the pedon reveals that the colour of the soil did not vary much between the horizons. It was brown to yellowish brown when the soil was dry and dark grayish brown when it was wet. Unlike the pedons from lake bottom, this pedon did not show any layer of high organic matter. This coupled with lack of

severe reduction and oxidation due to water logging and drainage may be the reason for uniform soil colour, down the different layers.

The Ap1 and Ap2 horizons were sandy clay loam whereas the lower layers were sandy clay. Sand fraction dominated the upper horizons, while there was an increase in the clay content in lower layers. There was not much variation in bulk density and particle density. Percentage surface layers were more porous which may be due to the artificial deposition of sandy material for reclamation.

The dry pH of the soil is very low with a mean pH of 3.9. Except for the 2nd horizon (Ap2) where the pH was 4.3, all the other horizon were having a pH 3.8. The KCl pH was further low with the mean at 3.3 Electrical conductivity was nil, proving that the soil was free from salts.

The organic carbon content was high in the surface horizon compared to the subsurface layers. The organic matter added to the soil as a manure accounts for the high organic carbon content of the top soil. The CEC is also higher in the upper horizon. The CEC is least in the C1

horizon, where organic matter content is also the least. The exchangeable hydrogen and aluminium content of all the horizon samples were quite low.

With regard to the nutrient status, the total nitrogen was high in the first two horizons. The mean total N content was 0.154 %.

The total phosphorus content did not change in a specific pattern, with a mean value of 0.028. Total K also followed the same trend.

Pedon 7 was identified from the South Eastern part of the lake and the area was under Banana cultivation for the past 10 years.

The colour of the soil is more or less uniform throughout the profile. It is pale brown when dry and brown when wet. The deeper horizons are little more darker. This may be due to the higher organic matter content and the wet condition prevailing in the deeper layers.

The clay content was found increasing with depth. The upper horizons viz. Ap1 and Ap2 were sandy clay loam.

The sand fraction was more in these two layers and they fall under the textural class sandy clay loam. The lower layers contained more clay. The bulk density decreased with depth and the particle density more or less the same except in Ap 2 where it decreased.

The dry pH of the sample did not show much variation. There was a slight decrease in the pH as the depth increased. The KCl pH also followed the same trend. No conductivity was obtained for the samples proving that the samples were free from salts. The organic carbon content was found increasing, eventhough there was a decrease in the C1 horizon. The increasing organic matter content and the increasing clay content resulted in the increase in CEC. The exchangeable hydrogen and aluminium content was very low. Total N content remained almost constant in the different layers but there was a slight decrease in the Ap2 horizon. Total P and total K followed the same trend.

Pedon 8. represents the western side of the college campus. The profile was taken from rice grown area.

The colour of the soil is slightly yellowish to reddish when compared to other profiles where the soil colour was brown or dark brown. Here, the upper horizons were more dark compared to the lower horizons. This must be due to the organic matter added for cultivation as well the decaying roots. Another characteristic feature of this pedon was the presence of reddish mottlings in the deeper layers.

Here also, the clay content of the soil increased as the depth of the profile increased. The Ap1 horizon was sandy loam where the sand fraction dominated. The deeper layer were clay where the clay fraction is in the range of 56-64%. As the clay content increased, the stickness of the soil also increased.

The bulk density of the soil first showed an increase upto Ap3 and then decreased. The particle density variation was not in a specific pattern. The percentage porosity was almost constant throughout the profile.

The dry pH of the soil didnot show much variation. The same was the case with KCl pH. The organic carbon value was high in the 1st horizon and last horizon. The CEC of the

soil first decreased and then showed an increase. Exchangeable hydrogen and aluminium had low value for all the samples.

The total nitrogen values did not change in a specific pattern whereas total phosphorus content decreased as the profile depth increased. Total K content showed a decrease in the Ap2 horizon and then showed an increase.

Pedon 9 was located in the northern side of the lake where the lake was reclaimed and brought under vegetable cultivation.

There was not much difference in the colour of the soil. The surface horizon were darker than the lower horizon. This must be due to the higher organic carbon content of the soil.

Physical analysis of the soil revealed that the same fraction was distributed almost equally throughout the profile. The texture was sandy clay in the upper horizons whereas it was sandy clay loam in the lowest horizon. The clay content decreased with increase in depth. The bulk

density and particle density did not vary much between horizon, but it was comparatively higher in the lowest horizon.

The dry pH was found decreasing with depth but the KCl pH was almost the same throughout the profile. No conductivity was obtained for any of the samples. The organic carbon values were comparatively higher with a mean value of 1.72. The organic carbon value was found decreasing with depth. The CEC decreased with increase in the depth of the profile. The decrease in organic carbon value can be one of the reasons for this. Exchangeable hydrogen and aluminium had low values proving that the soil was not potentially nor actively acidic. The total nitrogen, phosphorus and potassium showed variation but the change was not in any specific pattern.

Analysis of the surface samples collected at a radial distance of 100 m from each profile site showed that these didnot vary from the surface sample of the concerned profile. This showed that there was no difference in the parent material.

Water quality

Water samples were collected from five different locations in the lake and the pH, EC and chlonse content were analysed. The collection and analysis was done fortnightly from March 1993 to Feb 1994.

The samples were slightly acidic during most part of the year except during November December when water tends to be neutral to slightly alkaline. Not much variation was observed between the pH of the samples collected in one month.

The Samples collected were almost free of salts. The conductivity was almost nil for the samples collected during the whole year.

The chloride content of the samples were only in traces. The samples were free from chloride during march. The chloride content increased slightly during July - August after the receipt of the S.W monsoon. Maximum chloride content was obtained during December. Then the chloride level started decreasing. This is evident from the graph (Fig.).

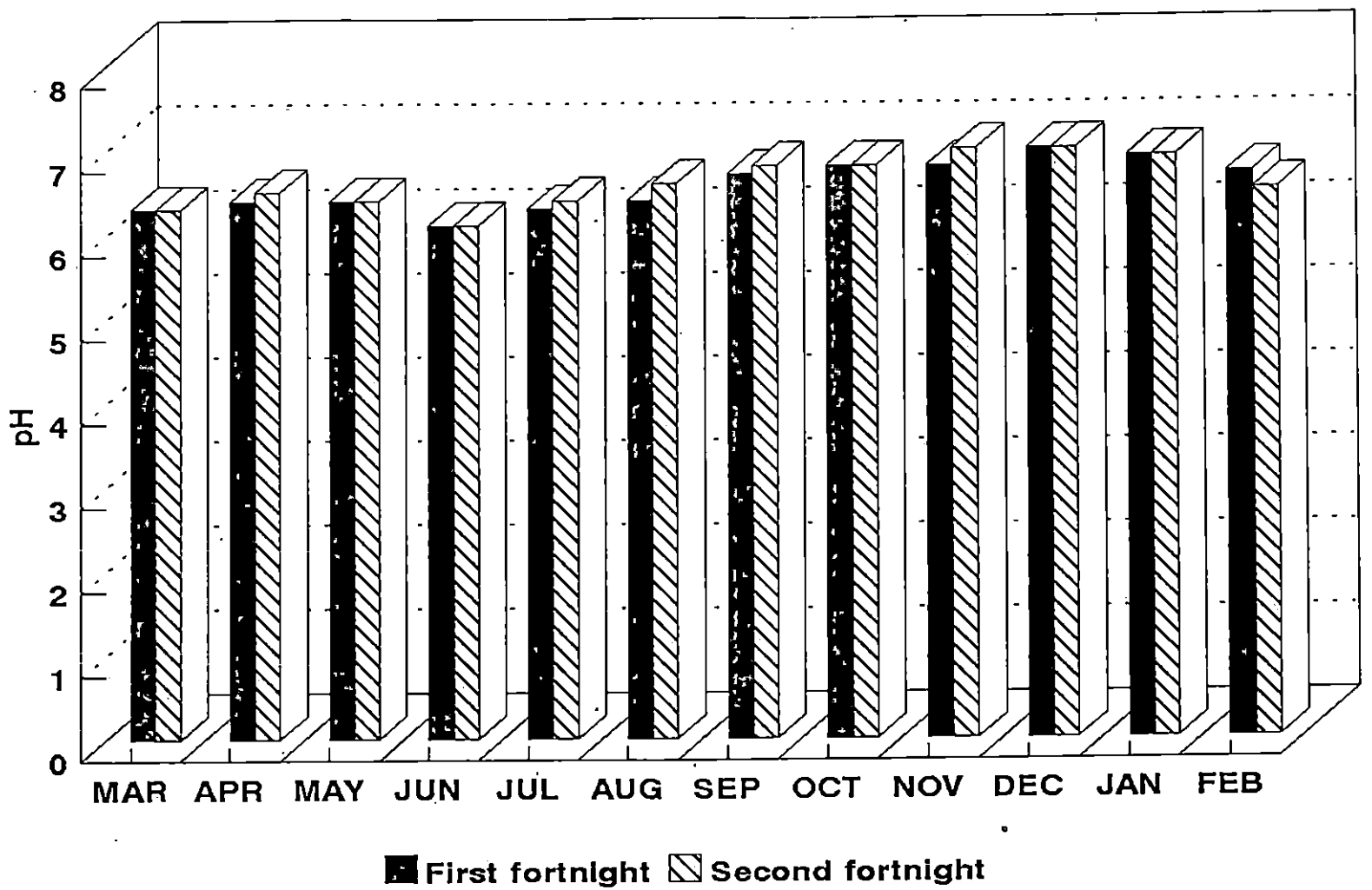


Fig. 3. Periodical variation of pH in water samples (ppm)

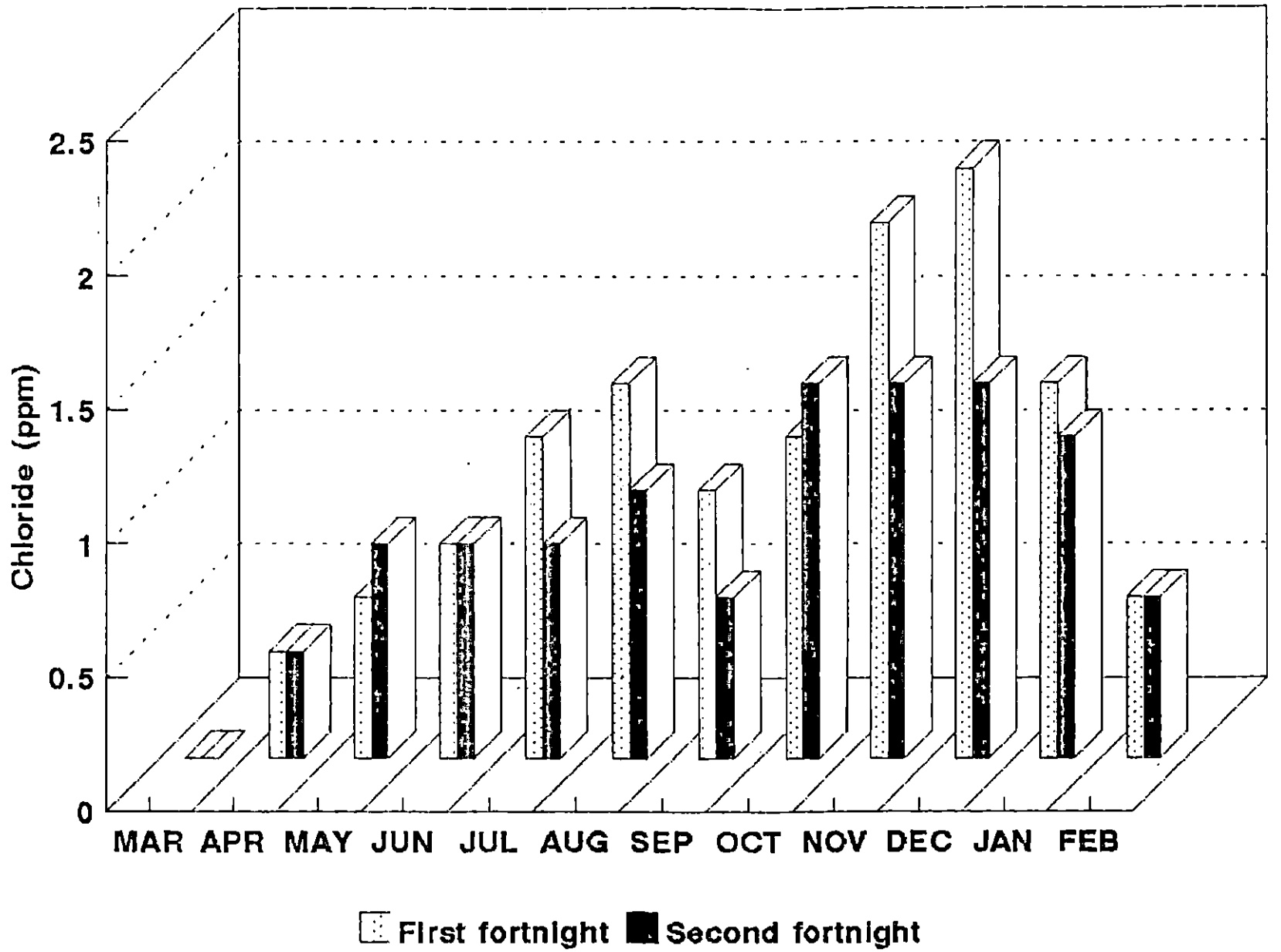


Fig. 4. Periodical variation of chloride in water samples (ppm)

The analysis of the water samples proved that the water was free from salts or carbonates of any kind, reflecting its high quality for domestic, agricultural or industrial purpose.

Fortnightly variation of pH, EC and chloride of lake bottom soil

The soil was comparatively acidic than the water samples. The pH was below 5.0 during most periods of the year. pH was slightly higher during November when it was just above 6.0. As a whole, pH did not show much variation during the whole year.

No sample collected showed conductivity showing that there was no high concentration of salts to cause salinity.

The chloride content of the soil was highest during December, when the mean value obtained for the five stations were 6.6 ppm. But the concentration was not high enough to cause salinity.

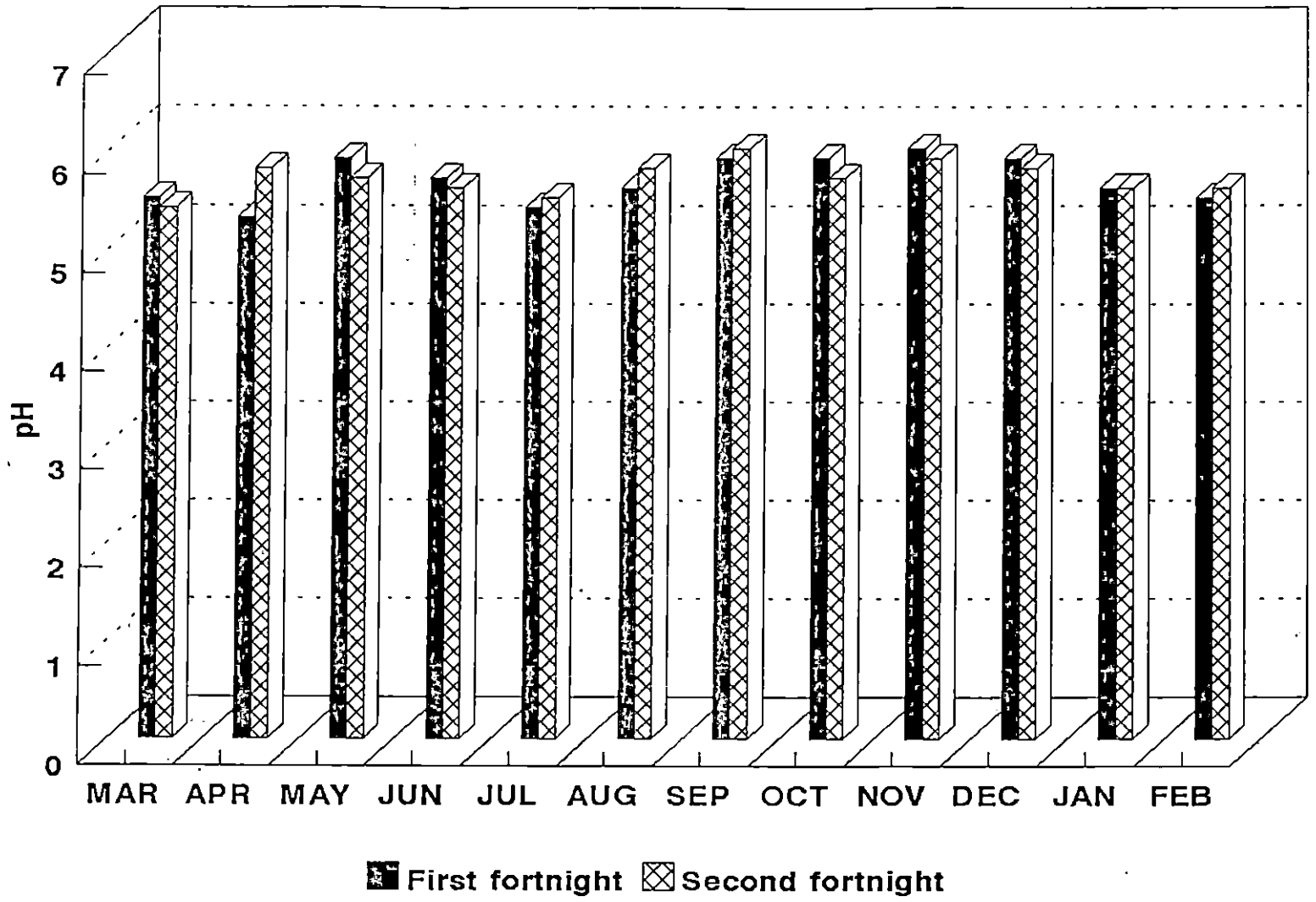


Fig. 5. Periodical variation of pH in soil samples

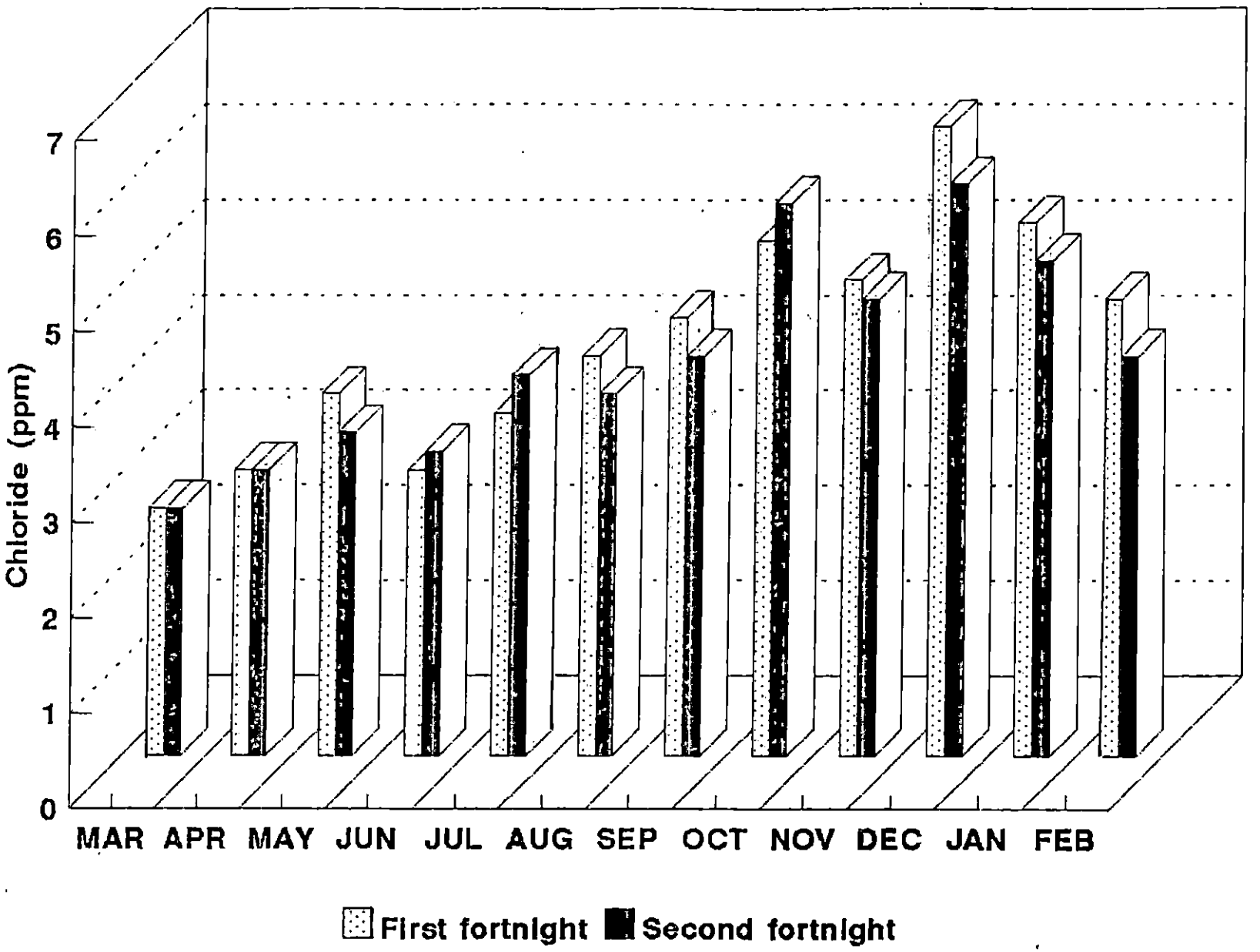


Fig. 6. Periodical variation of chloride in soil samples (ppm)

Bathymetry

The lake begins to swell up after the receipt of the south-west monsoon and attains its full volume and glory during December after the north-east monsoon is over. The depth of the lake was measured during this time. The lake is only 3 m deep even at the deepest part. No authentic reports are available on the depth of the lake. However, the local residents claim that the lake was over 5 m deep in the past. Taking this into consideration, the reason for the filling up can be attributed to siltation. 64 riverlets drain into this lake bringing along with it considerable amount of silt. Absence of scientific soil conservation measures in the adjoining uplands and hillocks having redloam soils (oxisols and oxisol-ultisol association) contribute to a great extent for the unabated situation of the lake. The southern portion of the lake is shallower when compared to the northern portion, indicating high siltation in the southern region. Geomorphological features of the adjoining uplands and intense human activity on south west part may be the reasons for higher siltation in the southern region. Eventhough no reports are available on the rate of siltation, it is clear that siltation is reducing the volume of the lake at an alarmingly fast rate.

Land use

The history of rice cultivation in Vellayani lake is a recent phenomenon and may not be more than half a century. Until recently, a major portion of the lake was used for single crop rice cultivation during Punja season (Dec-March). Traditional devices were used to pump out water during December, draining it to Karamana river through Madhupalam sluice. Short duration local varieties are used with minimum input of manures and fertilizers. The productivity of rice was marginal which ranged from 1500 kg to 2000 kg.

Subsequently, fringes of the lake were reclaimed by local farmers and the land was put to varied uses, culminating in the diminution of the actual lake area.

The present land use around the lake is predominantly coconut based. Limited area is under rice cultivation also. Rice is cultivated in the northern part of the lake where a bund has been constructed to separate the private property from government land. Rice is cultivated at around 60-70 acres of private land after dewatering.

Similarly rice is also cultivated in small pockets near the southern end of the lake. Anyhow, coconut enjoys the status of the crop with the maximum area. New seedings are planted on the sides of the lake after constructing bunds. Some pockets of land have been reclaimed from the lake by construction of bunds, dewatering and filling up with soil. This is now under banana and vegetables.

Trees of other kind also occupy considerable area. These are commonly associated with homesteads. These include Jack, Mango, Tamarind, Neem etc.

The Kerala Agricultural University campus occupies 75 ha of land near the Kayal. Different crops are cultivated in this area. The University also has reclaimed a considerable area of kayal by constructing bunds and planting coconut seedings.

As evident from the land use map, it may be seen that about 60% of the original lake area has been reclaimed in one way or other and put under intensive cultivation with coconut, rice, vegetables, mixed trees and bananas.

It may also be seen that draining the lake for rice cultivation during the period December to March coincides with the dry months of the region, when acute water shortage is experienced in the adjoining uplands for cultivation and domestic purposes.

In addition to this, indiscriminate use of fertilizers and pesticides for cultivation will certainly deteriorate the water quality and incorporate hazardous residues in the lake bed and also the water outlets.

Recently, the lake area under the control of Kerala Agricultural University of 165 ha is maintained as such and Punja rice cultivation has been abandoned. This is a wise step to restore the Vellayani fresh water lake ecosystem.

Fertility status

Analysis of the soil samples for available N, P and K reveal that these nutrients are present in high amounts in the lake soil. High available nitrogen is associated with the high amount of organic matter present in the lake bottom. Availability of phosphorus is also high which may due to the

low redox potential under waterlogged situation. Availability of potassium is medium in the analysed soil samples.

The nutrient status of the soil samples taken from reclaimed area did differ. Available nitrogen content was high on areas where coconut, banana and vegetables were grown. Whereas it was medium where rice was grown. This may be due to the high crop requirement and removal. Availability of phosphorus was high in all samples collected from reclaimed area. Potassium status was medium in samples from areas where Banana, Vegetables and rice were grown. But it was low in Coconut growing area. This may be due to the high crop requirement and removal.

SUMMARY

SUMMARY AND CONCLUSION

Lakes form fragile ecosystem which mirror the nation's ecological wealth. Due to population pressure, many lakes have been reclaimed or constantly encroached upon. The vellayani lake is one among the worstly affected ecosystems in Kerala. Though studies have been conducted in many other lake systems, a detailed study on the pedology and ecosystem of Vellayani lake is missing. The present study was undertaken with this as the objective. Studies were conducted on the soil samples collected from nine different pedons representing the lake bottom soil and four land use systems of the reclaimed area. Water samples also were collected periodically and analysed. Meteorological data of the location for a period of 11 years and for the period of study were collected and computed. After studying the different aspects of the lake, maps of land use, bathymetry and fertility status were prepared.

The results of the study may be summarised as follows.

The ambient temperature did not show much variation during the past eleven years. The mean monthly temperature of the summer and winter seasons did not vary much showing that they fall under isohyperthermic temperature regime. However, the monthly and annual rainfall showed much variation. The mean value for the past 50 years shows that the annual rainfall was 1840 mm, whereas, for the past 11 years, it was only 1520 mm, showing that there was a drastic reduction in the rainfall which is well reflected in the poor recharge of the lake. However, during the period under study the annual rainfall was well above the mean. Evapotranspiration was high during April-May and the total ET was higher than the mean annual rainfall showing a clean deficit in moisture.

Pedological studies of the lake indicated that there was no classical profile development or any characteristic diagnostic surface or subsurface horizons. hence the soil was included under Entisol. The profile features and prosperities of the reclaimed land differed entirely from that of the lake bottom profiles, showing that these soils were transported from elsewhere and the lake reclaimed.

Studies on the water quality indicated that the lake water was neither highly acidic nor highly alkaline. The water was free from salts or bicarbonates of any kind reflecting its high quality for domestic, agricultural or industrial purposes.

Seasonal variation of water and soil revealed that the water was slightly acidic during most part of the year aspect during November-December when water was neutral to slightly alkaline. Chloride content was maximum during December, though the mean values were not significantly high.

The lake bottom soil was acidic throughout the year. The pH was below 5.0 during most part of the year. Chloride content was higher than the water samples.

The bathymetric studies of the lake showed that the maximum depth of the lake was only 3m. The reservoir had an uniform depth of 108m. The decrease in depth was attributed to the heavy siltation.

Till recently, rice was cultivated in the lake after dewatering. Land use around the lake is predominantly

coconut based. In addition to coconut, paddy, mixed trees mixed crops and Banana are cultivated in the reclaimed areas around in lake.

Soil fertility investigations of the lake bottom soils revealed that the soil was highly productive which can be better utilised for aquaculture rather than agriculture.

Considering the different aspects, it can be seen that the ecosystem of the lake is fast degrading. Fringes of the lake were reclaimed and put to varied uses. About 60% of the original lake area has been reclained and put under intensive cultivation. So also, the draining of the lake resulted in acute water shortage in the adjoining uplands by lowering of water table.

Recently the lake area under the control of Kerala Agricultural University is maintained as such as the practice of draining for rice cultivation has been abandoned. This is a wise step to restore the Vellayani fresh water lake ecosystem. This has to be supplemented with other activities like desilting of the lake bed, adoption of engineering measures to prevent further siltation and introducing

scientific soil conservation practices in the surrounding uplands to prevent further deterioration of the lake. Ecofriendly practices like aquaculture should be followed in the lake. These measures, if implemented efficiently, will lead to the conservation of Vellayani lake for our future generations.

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APPENDIX

GENERAL VIEW

DEWATERING IN PROGRESS

TYPICAL PROFILE

CULTIVATION IN RECLAIMED AREAS

RECLAMATION & DEGRADATION

ABSTRACT

Lakes play the important role of storing the rain water and maintain the ground water table in the adjoining areas. They form a fragile ecosystem which reflect the nation's ecological wealth. Lakes, in India cover 0.2 million ha. In Kerala, there are 10 fresh water lakes.

During the recent past, due to population pressure, vast areas of lakes and other wetlands have been filled and reclaimed either for human inhabitation or for agricultural activities, resulting in serious ecological changes. Vellayani lake, which is the only fresh water lake in Trivandrum represents one of the worst affected ecosystem in Kerala. Not much have been studied about the different ecological and pedological aspects of this lake. The present study was undertaken to throw light on the nature of land use and characteristics of Vellayani lake ecosystem, the production potential of the soil, and the extent of degradation of the lake ecosystem.

Nine locations were selected to represent both the Kayal lands as well the lands reclaimed by human activity.

Profiles were taken from these locations and the samples were analysed for different physico-chemical characteristics. Water and soil samples were collected from the lake periodically and analysed for seasonal changes in pH, EC, chloride and sulphate. Climatological data of the station was also collected.

Results of the study prove that the lake ecosystem is fast degrading. Remote sensing techniques coupled with ground truth analysis have shown that 60% of the original lake area has been reclaimed. Due to heavy siltation, the average depth of the lake has been reduced to 3 m. Rainfall pattern of the location for a period of 11 years shows a drastic decline in the annual precipitation and the mean values has come down to 1520mm from 1840mm since 1982. Coconut is the predominant crop around the lake and the fringes of the lake have been reclaimed for different land uses. The predominance of crops in the reclaimed area are in the order rice, coconut, mixed trees, mixed crops, banana.

The water quality analysis has shown that the water is free from salts and can be safely used for domestic purposes as well for irrigation. The pedological

investigations on the lake soil system indicated that the lake bed soil is of recent origin and belongs to acid hydomorphic group. According to U.S. Soil taxonomy it can be classified as fine, Kaolinitic, isohypertheremic, acidic, tropic, fluvaquents. The lake bed is a highly productive soil system which can be better utilised for aquaculture rather than agriculture considering other ecological and environmental factors.

The step to abandon dewatering of the Kayal for cultivation has been a bold one from the part of the authorities and this coupled with other scientific conservation methods will prove a great deal in preserving this fragile ecosystem for future generations.