BIODIVERSITY PROJECT

ESTIMATION OF POPULATION DENSITY AND DIVERSITY OF MAJOR SOIL ANIMAL GROUPS IN RELATION TO RECENT FLOOD AFFECTED AREAS NEAR PAMPA RIVER

(SANCTION ORDER NO: A8/3371/2018/KSBB dt.1.12.18)

FINAL REPORT

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This to certify that this is the authentic record of work carried out by **Dr.M.G.Sanal Kumar., Head of the Department, Postgraduate and Research Department of Zoology** of this college under the **Biodiversity Flood Project Scheme** of the **Kerala State Biodiversity Board** for the project entitled **"Estimation Of Population Density and Diversity Of Major Soil Animal Groups In Relation To Recent Flood Affected Areas Near Pampa River"** (Sanction Order No: A8/3371/2018/KSBB dt.1.12.18). I have great pleasure in forwarding the report to Kerala State Biodiversity Board, Thiruvananthapuram.

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April 12, 2019

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DECLARATION

Certified that this project report is the bonafide record of the research work carried out by me at Postgraduate and Research Department of Zoology, N.S.S. College, Pandalam under the Biodiversity Flood Project Scheme of the Kerala State Biodiversity Board for the project entitled **"Estimation Of Population Density and Diversity Of Major Soil Animal Groups In Relation To Recent Flood Affected Areas Near Pampa River**" (Sanction Order No: A8/3371/2018/KSBB dt.1.12.18) and that this is not submitted for any other agencies/projects.

Pandalam **Dr.M.G.Sanal Kumar**

April 12, 2019

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Dr.M.G.Sanal Kumar

CONTENTS

INTRODUCTION

Soil is a living, dynamic and critical part of the terrestrial ecosystem supports several forms of life. Soils are a non-renewable natural resource vital for productivity in the terrestrial environment (Lavelle, 1996). Soil, the source of infinite life is the most vital and precious natural resource. The soil is one of the most valuable resources on this planet. Soil is one of the most essential and diverse natural habitat of biodiversity on earth. A healthy ecosystem has been defined as being stable and sustainable to maintain its organization, autonomy and resilience to stress over time (Costanza, 1992). Soil is a key habitat because not only it sustain the functionality of terrestrial ecosystems (Jeffery *et al.,* 2010; Menta, 2012). Soils are one of the last great frontiers for biodiversity research and are home to an extraordinary range of soil biota. In most ecosystems, the soil is extremely rich in invertebrates, which comprise a high proportion of the total biodiversity (Anderson, 1975).

Soil organisms provide important ecosystem services and contribute fundamentally to plant health. Soils were among the first terrestrial environments to be colonized because they possess environmental conditions that are intermediate between aquatic and aerial media (Lavelle and Spain, 2001). Soil is considered as one of the most important resources that support agriculture and livestock, the sustainability of food systems depends upon the healthy soils (Zhang *et al.,* 2007). Soil represents one of the most important reservoirs of biodiversity. Soil is among the most biologically diverse habitat to support wide varieties of living components in the form of flora and fauna on earth. Among the faunal components, there can be representatives of about 20 different lineages of arthropods, the most diverse phylum of living organisms.

Micro-arthropods have great ecological significance, in the breakdown and decomposition of litter, nutrient cycling and the role in secondary production and energy flow (Kaveri, 2010). Arthropods in soil act as “driving variables” indirectly affecting pathways of

energy transfer in soil. Arthropods in soil encompass a broad range of guilds, including specialised and polyphagous predators, parasites, phytophages, fungivores, microbivores, saprophages, detritivores and omnivores. Arthropods are the dominant animal group throughout the world. Without arthropods most terrestrial ecosystem would rapidly collapse (Iloba and Ekrakene, 2008; Wallwork 1970).

Soil, fauna perform important processes like degradation of organic biomass, mobilization of nutrients and enhancement of soil physicochemical properties (Moore and Walter, 1988). According to these functions, the organisms and microorganisms that live in the soil have been divided into three wide functional groups, they are chemical engineers, biological regulators and ecosystem engineers (Turbe *et al.,* 2010; Lavelle *et al.,* 2006). Ecosystem engineers are those organisms that physically modify the habitat, directly or indirectly regulating the availability of resources to other species and they control the stability and functioning of soil (Bagyaraj *et al.,* 2016).

Soil micro arthropods are sensitive as well as dependent on its ecological conditions, and respond to disturbance of soil structure, they could be good biological indicators of soil conditions. Soil arthropods are frequently used as ecological indicators to monitor environmental changes and ecosystem pressures (Mc Geoch 1998). Population density and composition of the fauna in soils are indicators of soil condition (Lussonhop, 1992; Stork and Eggleton, 1992). The abundance of micro arthropods in soil determined by resource availability, pH, disturbance and climatic factors (Curry, 1994).

The soil system represents a complex of abiotic and biotic factors that influence the biological community. Some environmental changes might alter habitat characteristics, which in turn may threaten the organism's homeostasis. Wallwork (1970) studied the qualitative and quantitative composition of the soil fauna and their relation with the different soil factors in respect to their population size and distribution pattern. In soil ecosystems, the status of soil biota at local and regional scales is influenced by different driving forces, such as forestry, agriculture, urbanization and seasonal fluctuation. Seasonal differences in the abundance of soil arthropods have been studied by various workers (Badejo, 1990; Lasebiken, 1974 and Usher, 1975). Their findings reported that micro arthropods undergo enormous fluctuations in densities, due to changes in microenvironment (Badejo, 1990).

Bellinger, (1954); Keven, (1962); Wallwork, (1976) and many others have stressed the importance of physico-chemical properties of the soil as a habitat of micro-arthropods. Soil arthropods measuring upto 10 mm. in length can be considered as micro-arthropods and considered to be members of mesofauna of the soil. Soil biota increases the surface area available for bacterial and fungal activities and converts humic substances to organic matter. Organic matter mixes with the mineral part of the soil and it forms the upper layer of the soil. Thus micro-arthropods play a role in the soil maturation, from the stand point of the development of humus horizon. The species interactions perform vital functions in a soil system, so that the study of prey-predator relationships is one of the fundamental themes in ecology.

Soil arthropod population abundance in soil relies on the number of factors such as competition and predation, presence or absence of organic matter, physio-chemical features of the soil such as temperature, moisture, compaction and pH which change from layer to layer in

soil, these factors lead in vertical stratifications and changes the vertical distribution of soil fauna (Bardgett, 2005). Gill (1969) demonstrated that physical factors in the environment were of major importance in determining the vertical distribution and abundance of soil micro arthropods and were not limited by the nutritional properties of the litter. Mukharji and Singh (1970) studied the soil micro arthropods in relation to the different edaphic factors and soil ecosystem at Banaras Hindu University, U.P. Micro-arthropod distribution can be influenced by soil moisture percentage, pore space, oxygen saturation deficits, temperature variations, floods, cropping, cultivation, organic matter percentage, litter, nematode populations, man and animal disturbances, soil type and texture, predation and feeding habits among others.

Soil is considered as a living tissue and the seat of biological activity due to the presence of teeming organisms. Soil biota constitutes the driving force of terrestrial ecosystems because they control the rate of turnover and mineralization of organic substrates. Soil biota's performs numerous activities like mixing, mounding, forming voids, regulating soil erosion, regulating movement of water and air in soil, regulating plant litter, regulating animal litter, regulating nutrient cycling, regulating biota, and producing special constituents through the processes of regurgitation, mixing of saliva or excreta with soil materials.

Soil fauna often used to provide soil quality indicators. Soil fauna (microfauna; protozoa, bacteria, meso fauna; Acarina, Symphyla, Collembola, Diplura and macro fauna; Chilopoda, Coleoptera, Orthoptera, Hymenoptera) interactions perform vital functions in a number of biological processes around the rhizosphere and within vicinity of decomposing organic matter. The soil micro-arthropods exercise a decisive role in the perpetuation of the productivity of soils, through their activities in the breakdown and decomposition of litter and organic matter. Soil characteristics of the natural systems such as forest and grass land along with the soil fauna have

been extensively studied by many workers. The most numerically abundant of the soil mesofauna are Acari and Collembola, which together constitute 72 to 97 percentage of the total arthropod fauna of Indian soils (Wall work, 1976).

Soil properties determine ecosystem function and vegetation structure, serve as a medium for root development, and provide moisture and nutrients for plant growth (Minnesota Forest Resources Council, 1999). Micro-arthropod distribution can be influenced by soil moisture percentage, pore space, oxygen saturation deficits, temperature variations, floods, cropping, cultivation, organic matter percentage, litter, nematode populations, man and animal disturbances, soil type and texture, predation and feeding habits among others (Christiansen, 1970; Rahim, 2008). Tousignant and Coderre (1992) showed that factors such as soil temperature, soil moisture etc. and concentration of nutrients were important in explaining the variation in numbers and community composition of micro arthropods.

Soil arthropod population abundance in soil relies on the number of factors- biotic interactions such as competition and predation, presence or absence of organic matter, physiochemical features of the soil such as temperature, moisture, compaction and pH which change from layer to layer in soil, these factors lead in vertical stratifications and changes the vertical distribution of soil fauna (Bardgett, 2005). Soil Nitrogen, Phosphorus and Potassium are the primary and essential nutrients for plant growth. Bhattacharya and Raychoudhuri (1979) noted that moisture content and temperature of soil, rainfall showed significant positive correlation with the total soil micro arthropods population. While studying the ecology and diversity of micro arthropods in canopy and soil from tropical evergreen forest of Cachar district, Assam Ray *et al.*, (2012) concluded that edaphic factors and climatic factors affect the dynamics of micro arthropods.

Arthropods are part of important functional groups in soil food webs. Soil micro arthropods contribute to the breakdown of organic matter in several ways. Micro-arthropods disintegrate plant and animal tissues and transform to humic substances. Any land use which affects the soil structure or alters the soil chemistry affect the soil fauna. Land use change alters the below ground physico-chemical characteristics, often leading to loss of biodiversity and concomitant depletion of soil nutrients. Land use change and agricultural intensification generate severe habitat degradation or destruction for soil biota (Decaens *et al.,* 2006). Among these impacts the reduction in soil biodiversity and degradation of soil quality are often viewed as major threats for the future (Solbrig, 1991).

Intensified agri-farming deteriorates the soil key processes and resulting negative impact on soil, hydrological processes, detoxification, gas exchange, structure and recycling of organic matter (Rana *et al.,* 2010). Soil arthropod biodiversity is an indicator of soil quality. The ecosystem services provided by soil fauna are one of the most powerful arguments for the conservation of edaphic biodiversity.Soil quality is the result of continuous conservation and degradation processes, and it represents the capacity of soil to function as a healthy living ecosystem (Muscolo *et al.,* 2014).

Government departments, agencies, boards, and private sector companies and organizations with interests in ecosystem management should act to support the acquisition of ecosystem baselines of arthropod biodiversity. Rombke *et al.,* (2005) suggested that protecting soil ecosystem biodiversity would contribute to maintaining the functional sustainability of the soil ecosystem. Such a healthy ecosystem provides a myriad of services. Conversely, an ecosystem that is unhealthy, as are so many of the earth's ecosystems, suffers from impaired

functions and is far less capable of providing ecosystem services. Borrowing terminology from human health, such unhealthy ecosystems are said to suffer from ecosystem distress syndrome (EDS) (Rapport *et al.,* 1985). Soils are a natural resource that must be secured for future generations, as rates of soil formation or recovery are often too. Modern agricultural practices, such as, use of heavy machinery for tillage operation, chemical fertilizers, and pesticides, have led to severe impacts on the soil ecosystem. Among these impacts the reduction in soil biodiversity and degradation of soil quality are often viewed as major threats for the future (Solbrig, 1991).

OBJECTIVES

- To identify the major soil biota with special reference to soil micro arthropods in the flood affected areas of river Pampa.
- To estimate the density of soil biota in the flood affected areas of river Pampa.
- To compare the status and density of soil biota with pre flood data available.

MATERIALS AND METHODS

STUDY AREAS

Flood affected areas of Pampa River basin from Ranni to Chengannur were studied. The study area cover 3 Taluks: a. **Ranni Taluk** b. **Kozhencherry Taluk** c. **Chengannur Taluk.** Sampling sites in Ranni taluk were Ayiroor, Ranni, Chettakkal, Cherkolpuzha and Perunad. Sampling sites in Kozhencherry taluk were Aranmula, Neervilakkam, Koyipuram, Arattupuzha and Malakkara. Sampling sites in Chengannur Taluk were Chenngannur Municipality, Pandanad, Thiruvanmandur, Venmony and Aala Panchayath.

a. SOIL COLLECTION, SAMPLING AND ANALYSIS

Five sampling sites from each area were selected and soil samples collected from before flood and after flood. A soil auger was used to collect samples. Soil samples were collected from 0-20, 20-40 and 40-60 cm layers of the soil pit random collected from each study area from different seasons. Samples were pooled, air dried and passed through 2 mm sieve. The sand, silt and clay contents were analyzed by Particle size analysis, pipette method. Soil pH measured by pH meter in water suspension (1:2 ratio). Organic carbon content by Walkley Black acid digestion method (1934), total Nitrogen by Kjeldahl distillation method; Phosphorus content by Molybdate-Stannous chloride method; Potassium content by flame photometry method (APHA, 2005 and APHA, 2012); Exchangeable Acid, Exchangeable base, Calcium and Magnesium by the methods of Jackson (1958). Soil temperature was measured using a soil thermometer.

Five soil samples were collected from study sites during post monsoon and summer season. Mean value along with standard error was calculated then converted in to area in m^2. Then data were converted to seasonal data by taking November and December as post monsoon; January and February as summer. Mean and Standard error was calculated. Two way ANOVA test was conducted to find out any significant variation in the edaphic and chemical factors in the

study area, before flood and after flood. The Principal Component analysis was conducted to find out the soil factors controlling the population density and distribution pattern of *Philoscia javanensis*, using Minitab 17.

b. POPULATION DENSITY OF SOIL FAUNA

- **Collection, extraction, sorting and preservation of soil fauna:**

Soil samples were collected from flood affected areas of Pampa River basin from Ranni to Chengannur. Soil samples of 5×5 cm^2 area, from a depth of 5 cm randomly collected with soil auger. Soil samples were collected in all seasons this was carried out between the hours of 8.00 am to 10.00 am in the morning. Soil samples were placed in a labelled polythene covers and taken to the laboratory.

Collected soil samples placed into a 15×25 cm tray and hand sorted to collect large soil microarthropods. Remaining soil samples were transferred to the Berlese Tullgren funnel for soil arthropods extraction. Berlese Tullgren Funnel extractor is the best extraction method for extracting soil arthropods. The soil micro arthropods were extracted overnight into a picric acid medium (Haarlov, 1947). Extracted micro arthropods were identified with the help of a binocular stereo microscope and used identification key (Kuhnelt, 1961 and Wallwork 1970). After the organisms were extracted and collected, they were sorted. This was done under a binocular dissecting microscope. The density of soil fauna was calculated. The data from the sample were converted in to area in m^2 and mean value along with standard error was calculated. Two way ANOVA test was conducted to find out any significant variation in the population density of soil biota in the flood affected areas of river Pampa with pre flood situation in this study area. PCA was done to find out principal soil factors affecting the population density of micro arthropods in these areas.

RESULTS

SOIL PHYSICO-CHEMICAL PROPERTIES- BEFORE FLOOD

(Source: R.S.Balamurali and M.G.Sanal Kumar; Manoharan P.P.,M.G.Sanal Kumar and P.M.Remya)

RANNI AREA-BEFORE FLOOD

1.1.1 Soil edaphic and chemical properties in Ranni area before flood

TEMPERATURE (^{0}C)

The mean soil temperature during November month was 26.7˚C, 26.7 ˚C in December. 30.4˚C in January and 30.1˚C in February (Table 1.1.1). There is significant variation in soil temperature between months (F=40.31989, P<0.05) and no difference between sites (F=0.58372, P>0.05) (Table 1.1.1).

Table 1.1.1: Temperature of the soil at different study sites during post monsoon and summer season (Before flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Ayiroor	26.3	27	30.6	30.5
Ranni	27.4	26.5	29.6	29
Chettakkal	26	26.5	30.5	30.5
Cherkolpuzha	28	27	29.3	30.6
Perunad	26	26.5	30.2	30
Mean ±SE	26.74±0.909	26.7±0.274	30.04±0.568	30.12±0.669

Table 1.1.2 : Two way ANOVA showing Temperature of the soil at different study sites during post monsoon and summer season (Before flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	1.09	4	0.2725	0.58372	0.680444	3.259167
Between Samples	56.468	3	18.82267	40.31989	1.52E-06	3.490295
Error	5.602	12	0.466833			
Total	63.16	19				

pH

The pH value was high in post monsoon season (6.49, 6.31) followed by summer season (5.49, 5.34) (Table 1.1.3).

Table 1.1.3: p^H of the soil at different study sites during post monsoon and summer season (Before flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Ayiroor	6.23	6.5	5.27	5.5
Ranni	6.5	6.6	5.36	5.62
Chettakkal	6.4	6.5	5.95	5.42
Cherkolpuzha	6.08	6.34	5.11	5.3
Perunad	6.34	6.55	5	5.6
Mean ± SE	6.31±0.161	6.498±0.098	5.338±0.369	5.488±0.132

There is no significant difference in the pH between sites (F=2.214916, P>0.05) and there is difference between seasons (F=46.34333, P<0.05) (Table 1.1.3)

Table 1.1.4 : Two way ANOVA showing p^H of the soil at different study sites during post monsoon and summer season (Before flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.32213	4	0.080533	2.214916	0.128609	3.259167
Between Samples	5.055015	3	1.685005	46.34333	7.12E-07	3.490295
Error	0.43631	12	0.036359			
Total	5.813455	19				

ORGANIC CARBON (%)

The value of organic carbon percentage was 3.56 during post monsoon and 4.47-4.42 during summer season. (Table 1.1.5). There is no significant difference in the pH between sites (F=1.090731, P>0.05) and there is difference between seasons (F=17.3676, P<0.05) (Table 1.1.6)

Table 1.1.5: Organic carbon content of the soil at different study sites during post monsoon and summer season (Before flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Ayiroor	3.5	3.52	4.25	4
Ranni	3.8	3.7	4.65	4.69
Chettakkal	3.47	3.9	4	4.85
Cherkolpuzha	3.5	3.2	4.85	4.32
Perunad	3.57	3.45	4.36	4.5
Mean ± SE	3.568±0.135	3.554±0.264	4.422±0.334	4.472±0.331

Table 1.1.6: Two way ANOVA showing Organic carbon content of the soil at different study sites during post monsoon and summer season (Before flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.32923	4	0.082308	1.090731	0.404448	3.259167
Between Samples	3.93172	3	1.310573	17.3676	0.000116	3.490295
Error	0.90553	12	0.075461			
Total	5.16648	19				

EA AND EB (%)

Exchangeable acid value varied from an average of 75.97% in summer to 83.59% in post monsoon. Exchangeable Base value varied from an average of 6.51% in post monsoon to 5.65% in monsoon (Table 1.1.7 and 1.1.9).

Table 1.1.7 : Exchangeable Acid of the soil at different study sites during post monsoon and summer season (Before flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Ayiroor	83.45	85.34	77.25	80.23
Ranni	80	84.1	75.69	74.4
Chettakkal	82.34	82.69	70.25	76.23
Cherkolpuzha	85.4	83.44	78.69	70.1
Perunad	82	82.37	74.6	78.9
Mean ±SE	82.638±1.983	83.588±1.189	75.296±3.219	75.972±3.99

Table 1.1.8 : Two way ANOVA showing Exchangeable acid of the soil at different study sites during post monsoon and summer season (Before flood)

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	30.97568	4	7.74392	0.972328	0.458054	3.259167
Between Samples	283.0759	3	94.35863	11.84769	0.000671	3.490295
Error	95.57168	12	7.964307			
Total	409.6233	19				

Table 1.1.9: EB of the soil at different study sites during post monsoon and summer season (Before flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Ayiroor	6.12	6.44	5.8	5.5
Ranni	6.89	6.25	5.36	5.48
Chettakkal	6.1	6.85	5.64	5.36
Cherkolpuzha	6.22	6.17	5.98	5.48
Perunad	6.48	6.85	5.47	5.14
Mean± SE	6.362±0.332	6.512±0.324	5.65±0.248	5.392±0.151

In both case, there was no difference in values between sites ($P>0.05$) and there is difference between seasons ($P<0.05$) (Table 1.1.8 and 1.1.10).

Table 1.10 : Two way ANOVA showing EB of the soil at different study sites during post monsoon and summer season (Before flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.00333	4	0.000833	0.008355	0.99984	3.259167
Between Samples	4.41794	3	1.472647	14.7793	0.000248	3.490295
Error	1.19571	12	0.099643			
Total	5.61698	19				

SAND (%)

The sand percentage was high in summer season with an average of 75.15% followed by post monsoon (64.33%). (Table 1.1.11).

Table 1.1.11: Sand content of the soil at different study sites during post monsoon and summer season (Before flood)

	Post monsoon		Summer	
Sites	November	December	January	February
Ayiroor	64.23	63.47	70.25	72.36
Ranni	65.4	65.51	75.36	75
Chettakkal	62.38	67.23	72.33	75.6
Cherkolpuzha	60.4	63.47	79.45	78.55
Perunad	68.23	62	74.25	74.25
Mean ± SE	64.128±2.975	64.336±2.043	74.328±3.461	75.152±2.257

The two way ANOVA result revealed that there is no significant variation in the sand content of various sites ($F=0.647715$, $P>0.05$) and significant variation in the content between seasons ($F=22.37012$, $P<0.05$) (Table 1.1.12).

Table 1.1.12 : Two way ANOVA showing Sand content of the soil at different study sites during post monsoon and summer season (Before flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	21.38368	4	5.34592	0.647715	0.639156	3.259167
Between Samples	553.8959	3	184.632	22.37012	3.33×10^{-05}	3.490295
Error	99.04208	12	8.253507			
Total	674.3217	19				

SILT (%)

The value of silt content percentage was 22.19 during November month, 23.72 in December, 19.09 in January and 18.09 during February month. (Table 1.1.13). There is no significant difference in the silt percentage between sites ($F=1.396834$, $P>0.05$) and there is difference between seasons ($F=15.77923$, $P<0.05$) (Table 1.1.14)

Table 1.1.13: Silt content of the soil at different study sites during post monsoon and summer season (Before flood)

	Post monsoon		Summer	
Sites	November	December	January	February
Ayiroor	20.14	23.15	18.25	18.8
Ranni	22.5	23.7	19.36	17
Chettakkal	26.47	25	20.18	17.5
Cherkolpuzha	21.5	22.4	19.66	17.59
Perunad	20.37	24.36	18	19.58
Mean ± SE	22.196±2.569	23.722±1.014	19.09±0.632	18.094±1.061

Table 1.1.14 : Two way ANOVA showing Silt content of the soil at different study sites during post monsoon and summer season (Before flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	12.23457	4	3.058643	1.396834	0.293227	3.259167
Between Samples	103.6552	3	34.55173	15.77923	0.000182	3.490295
Error	26.27635	12	2.189696			
Total	142.1661	19				

CLAY (%)

The clay percentage was high in post monsoon season followed by summer season. (Table 1.1.15).

Table 1.1.15: Clay content of the soil at different study sites during post monsoon and summer season (Before flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Ayiroor	11.32	12.3	6.25	6.98
Ranni	10.58	11.82	6.36	6.48
Chettakkal	12.3	13.62	6.48	6.25
Cherkolpuzha	9.52	10.3	6.6	6.18
Perunad	15.45	10.42	6	6.22
Mean± SE	11.834±2.262	11.692±1.383	6.338±0.229	6.422±0.333

The two way ANOVA result revealed that there is no significant variation in the clay content of various sites ($F=0.782985$, $P>0.05$) and significant variation in the content between seasons ($F=25.38852$, $P<0.05$) (Table 1.1.16).

Table 1.1.16 : Two way ANOVA showing Clay content of the soil at different study sites during post monsoon and summer season (Before flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	5.96043	4	1.490108	0.782985	0.557605	3.259167
Between Samples	144.9515	3	48.31717	25.38852	1.75×10^{-05}	3.490295
Error	22.83733	12	1.903111			
Total	173.7493	19				

NITROGEN (ppm)

The Nitrogen content was 2362.13ppm during November month, 2369.69ppm in December, 2379.41 ppm in January and 2381.06 ppm during February month. (Table1.1.17).

There is no significant difference in the Nitrogen content between sites (F=0.595341, P>0.05) and there is difference between seasons (F=8.299317, P<0.05) (Table 1.1.18).

Table 1.1.17: Nitrogen content of the soil at different study sites during post monsoon and summer season (Before flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Ayiroor	2368.26	2374.39	2380	2385.85
Ranni	2354	2369.24	2386.35	2381.06
Chettakkal	2367.31	2361.22	2379.25	2388.3
Cherkolpuzha	2361.1	2378.06	2367.45	2375.73
Perunad	2360	2365.51	2384	2374.36
Mean ± SE	2362.134±5.834	2369.684±6.738	2379.41±7.292	2381.06±6.097

Table 1.1.18 : Two way ANOVA showing Nitrogen content of the soil at different study sites during post monsoon and summer season (Before flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	112.4292	4	28.10729	0.595341	0.672834	3.259167
Between Samples	1175.484	3	391.828	8.299317	0.002946	3.490295
Error	566.5449	12	47.21207			
Total	1854.458	19				

PHOSPHORUS (ppm)

The Phosphorus content was high in Post monsoon (9.39ppm) followed by summer (8.55ppm) (Table 1.1.19).

Table 1.1.19: Phosphorus content of the soil at different study sites during post monsoon and summer season (Before flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Ayiroor	9.36	9.36	8.36	8.22
Ranni	9.25	9.2	8.36	8.47
Chettakkal	9	9.64	8.9	8.51
Cherkolpuzha	9.33	9.78	8.06	8.26
Perunad	9.08	9	9.1	8.34
Mean ± SE	9.204±0.158	9.396±0.318	8.556±0.429	8.36±0.127

There is no significant difference in the Phosphorus content between sites (F=0.245632, P>0.05) and there is difference between seasons (F=12.38324, P<0.05) (Table 1.1.20)

Table 1.1.20 : Two way ANOVA showing Phosphorus content of the soil at different study sites during post monsoon and summer season (Before flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.09873	4	0.024682	0.245632	0.906821	3.259167
Between Samples	3.73302	3	1.24434	12.38324	0.000552	3.490295
Error	1.20583	12	0.100486			
Total	5.03758	19				

POTASSIUM (ppm)

The Potassium content was high in Post monsoon (138.79ppm) followed by summer (119.53ppm) (Table 1.1.21). There is no significant difference in the Potassium content between sites (F=0.916256, P>0.05) and there is difference between seasons (F=26.71194, P<0.05) (Table 1.1.22)

Table 1.1.21: Potassium content of the soil at different study sites during post monsoon and summer season (Before flood)

	Post monsoon		Summer	
Sites	November	December	January	February
Ayiroor	135.68	136.45	118.56	120.36
Ranni	132.36	130.4	120.35	119.64
Chettakkal	139.2	143.72	116.47	117.23
Cherkolpuzha	132	148.63	123.6	121.78
Perunad	140.38	134.77	118.7	115.38
Mean ± SE	135.924±3.832	138.794±7.299	119.536±2.657	118.878±2.556

Table 1.1.22 : Two way ANOVA showing Potassium content of the soil at different study sites during post monsoon and summer season (Before flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	76.33882	4	19.08471	0.916256	0.48573	3.259167
Between Samples	1669.15	3	556.3834	26.71194	1.35×10^{-05}	3.490295
Error	249.9482	12	20.82902			
Total	1995.437	19				

CALCIUM (ppm)

The Calcium content was an average of 627.55ppm in post monsoon and 590.42 ppm during summer season. (Table 1.1.23). There is no significant difference in Calcium content between sites ($F=1.138457$, $P>0.05$) and between seasons there is variation ($F=88.01751$, $P<0.05$) (Table 1.1.24).

Table 1.1.23: Calcium content of the soil at different study sites during post monsoon and summer season (Before flood)

	Post monsoon		Summer	
Sites	November	December	January	February
Ayiroor	625.38	628.44	582.31	584.24
Ranni	627.23	623.73	591.33	590.29
Chettakkal	637.15	620.1	590.8	596.47
Cherkolpuzha	629.47	628	596.46	593.72
Perunad	630	637.49	591.22	585.3
Mean ± SE	629.846±4.48	627.552±6.517	590.424±5.096	590.004±5.269

Table 1.1.24 : Two way ANOVA showing Calcium content of the soil at different study sites during post monsoon and summer season (Before flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	127.9487	4	31.98718	1.138457	0.384621	3.259167
Between Samples	7419.073	3	2473.024	88.01751	1.94×10^{-08}	3.490295
Error	337.1635	12	28.09696			
Total	7884.185	19				

MAGNESIUM (ppm)

The Magnesium content was an average of 115.65ppm in post monsoon to 140.12ppm in summer (Table 1.1.25). There is no significant difference in Magnesium content between sites ($F=0.384534$, $P>0.05$) and between seasons there is variation ($F=40.67197$, $P<0.05$) (Table 1.1.26).

Table 1.1.25: Magnesium content of the soil at different study sites during post monsoon and summer season (Before flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Ayiroor	108.25	115.46	140.23	143.77
Ranni	112.35	109.22	136.95	138.42
Chettakkal	119.65	113.64	138.23	132.6
Cherkolpuzha	110.85	119.57	132.1	140.2
Perunad	105.23	120.36	143.36	145.6
Mean ± SE	111.266±5.413	115.65±4.554	138.174±4.168	140.118±5.068

Table 1.1.26 : Two way ANOVA showing Magnesium content of the soil at different study sites during post monsoon and summer season (Before flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	42.31667	4	10.57917	0.384534	0.815606	3.259167
Between Samples	3356.863	3	1118.954	40.67197	1.45×10^{-06}	3.490295
Error	330.1402	12	27.51169			
Total	3729.32	19				

MOISTURE (%)

The moisture content also varied from an average of 72% in summer to 75.8% in post monsoon. (Table 1.1.27). There is no significant difference in Moisture content between sites ($F=2.037901$, $P>0.05$) and between seasons there is variation ($F=6.641399$, $P<0.05$) (Table 1.1.28).

Table 1.1.27 : Two way ANOVA showing moisture content of the soil at different study sites during post monsoon and summer season (Before flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Ayiroor	76	77	70	74
Ranni	75	75	72	73
Chettakkal	72	78	73	71
Cherkolpuzha	73	73	71	70
Perunad	78	76	74	72
Mean ± SE	74.8±2.38	75.8±1.923	72±1.581	72±1.581

Table 1.1.28 : Two way ANOVA showing moisture content of the soil at different study sites during post monsoon and summer season (Before flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	23.3	4	5.825	2.037901	0.152811	3.259167
Between Samples	56.95	3	18.98333	6.641399	0.006807	3.490295
Error	34.3	12	2.858333			
Total	114.55	19				

Fig. 1.1: Mean soil edaphic factors of the study area (Ranni) during post monsoon season (Before flood and after flood

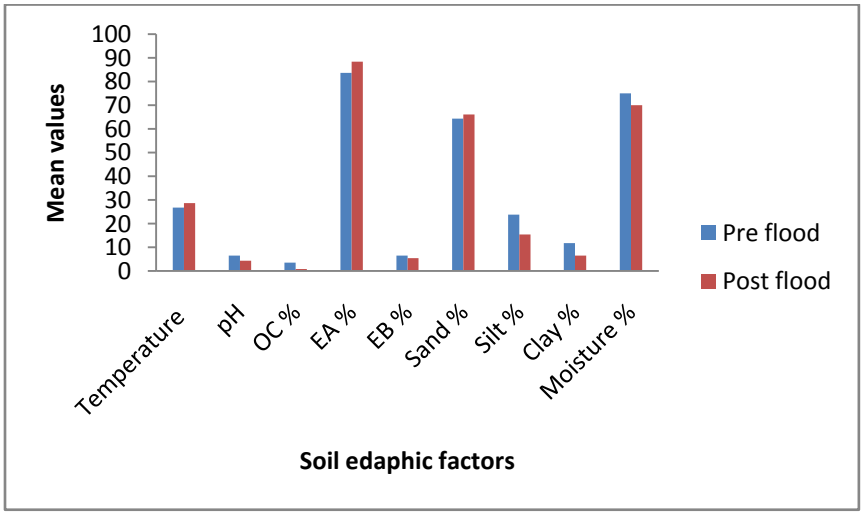
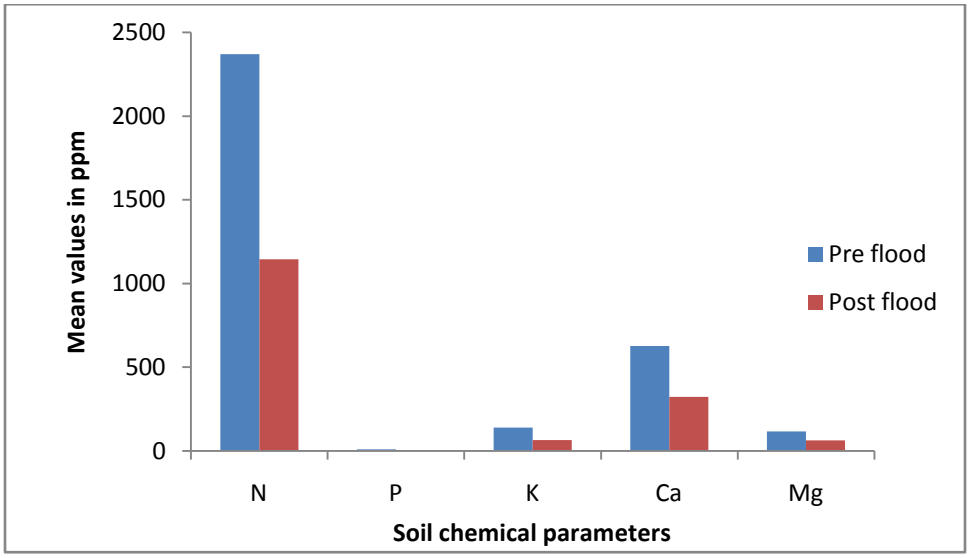


Fig. 1.2: Mean soil chemical factors of the study area (Ranni) during post monsoon season (Before flood and after flood



RANNI AREA-AFTER FLOOD

1.2.1 Soil edaphic and chemical properties in Ranni area after flood

(TEMPERATURE (^{0}C)

The mean soil temperature during November month was 28.5˚C, 28.6 ˚C in December. 30.5˚C in January and 30.8˚C in February (Table 1.2.1).

Table 1.2.1: Temperature of the soil at different study sites during post monsoon and summer season (After flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Ayiroor	28.5	28.5	30.5	30.5
Ranni	29	29.3	29.8	31.8
Chettakkal	28	28.4	30.5	30.5
Cherkolpuzha	28.6	28.6	31.2	30.7
Perunad	28.4	28.5	30.5	30.6
Mean ± SE	28.5±0.360	28.66±0.364	30.5±0.494	30.82±0.554

There is significant variation in soil temperature between months (F=38.97381, P<0.05) and no difference between sites (F=1.340879, P>0.05) (Table 1.2.2).

Table 1.2.2 : Two way ANOVA showing Temperature of the soil at different study sites during post monsoon and summer season (After flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within samples	1.007	4	0.25175	1.340879	0.3109	3.259167
Between Samples	21.952	3	7.317333	38.97381	1.83E-06	3.490295
Error	2.253	12	0.18775			
Total	25.212	19				

pH

The pH value was high in post monsoon season (6.28) followed by summer season (4.54, 5.34) (Table 1.2.3). There is no significant difference in the pH between sites F=0.274648 and F=2.602113 P>0.05 seasons) (Table 1.2.4)

Table 1.2.3:p^H of the soil at different study sites during post monsoon and summer season (After flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Ayiroor	4	4.5	4.5	4.5
Ranni	4.2	4.3	4.8	4.6
Chettakkal	4.1	4.3	4.6	4.3
Cherkolpuzha	4.6	4.2	4.2	4.5
Perunad	4.3	4.1	4.5	4.8
Mean ± SE	4.24±0.230	4.28±0.148	4.52±0.216	4.54±0.182

Table 1.2.4 : Two way ANOVA showing p^H of the soil at different study sites during post monsoon and summer season (After flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Withi Samples	0.052	4	0.013	0.274648	0.888718	3.259167
Between Samples	0.3695	3	0.123167	2.602113	0.100282	3.490295
Error	0.568	12	0.047333			
Total	0.9895	19				

ORGANIC CARBON (%)

The value of organic carbon percentage was 0.744 during post monsoon and 0.838 during summer season. (Table 1.2.5).

Table 1.2.5: Organic carbon of the soil at different study sites during post monsoon and summer season (After flood)

	Post monsoon		Summer	
Sites	November	December	January	February
Ayiroor	0.7	0.75	0.81	0.84
Ranni	0.72	0.74	0.78	0.8
Chettakkal	0.76	0.72	0.86	0.85
Cherkolpuzha	0.8	0.77	0.84	0.84
Perunad	0.74	0.74	0.84	0.86
Mean ± SE	0.744±0.0384	0.744±0.0181	0.826±0.031	0.838±0.022

There is no significant difference in the pH between sites ($F=3.139104$, $P>0.05$) and there is difference between seasons ($F=24.16074$, $P<0.05$) (Table 1.2.6)

Table 1.2.6 : Two way ANOVA showing Organic carbon content of the soil at different study sites during post monsoon and summer season (After flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.00677	4	0.001693	3.139104	0.055396	3.259167
Between Samples	0.03908	3	0.013027	24.16074	2.26E-05	3.490295
Error	0.00647	12	0.000539			
Total	0.05232	19				

EA AND EB (%)

Exchangeable acid value varied from an average of 81.76% in summer to 88.43% in post monsoon. Exchangeable Base value varied from an average of 4.5% in summer to 5.46% in post monsoon (Table 1.2.7 and 1.2.9).

Table 1.2.7: EA Content of the soil at different study sites during post monsoon and summer season (After flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Ayiroor	85.26	89.6	82.3	82.3
Ranni	86.34	87.12	81.6	83.45
Chettakkal	89.33	88.36	81.45	80.14
Cherkolpuzha	86.35	89.64	80.26	81.26
Perunad	85.15	87.46	80.39	81.65
Mean ±SE	86.486±1.689	88.436±1.172	81.2±0.862	81.76±1.228

Table 1.2.8 : Two way ANOVA showing EA Content of the soil at different study sites during post monsoon and summer season (After flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	3.85577	4	0.963943	0.524322	0.720014	3.259167
Between Samples	189.1521	3	63.05069	34.29546	3.63E-06	3.490295
Error	22.06147	12	1.838456			
Total	215.0693	19				

Table 1.2.9: EB Content of the soil at different study sites during post monsoon and summer season (After flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Ayiroor	5.4	5.26	4.31	4.26
Ranni	5.6	5.16	4.69	4.51
Chettakkal	5.9	5.22	4.51	4.22
Cherkolpuzha	5.3	5.98	4.23	4.36
Perunad	5.14	5.46	4.8	4.84
Mean ± SE	5.468±0.293	5.416±0.334	4.508±0.243	4.438±0.251

In both case, there was no difference in values between sites (P>0.05) and there is difference between seasons (P<0.05) (Table 1.2.8 and 1.2.10).

Table 1.2.10 : Two way ANOVA showing EB Content of the soil at different study sites during post monsoon and summer season (After flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.13675	4	0.034187	0.358921	0.833055	3.259167
Between Samples	4.713815	3	1.571272	16.49615	0.000148	3.490295
Error	1.14301	12	0.095251			
Total	5.993575	19				

SAND (%)

The sand percentage with an average of 66.43% in post monsoon followed by 75.35% during summer (Table 1.2.11). The two way ANOVA result revealed that there is no significant variation in the sand content of various sites (F=1.579893, P>0.05) and significant variation in the content between seasons (F=44.17933, P<0.05) (Table 1.2.12).

Table 1.2.11: Sand content of the soil at different study sites during post monsoon and summer season (After flood)

	Post monsoon		Summer	
Sites	November	December	January	February
Ayiroor	68.23	65.98	72.36	75.36
Ranni	65.23	64.23	72.16	74.26
Chettakkal	66.36	65.2	73.69	75.26
Cherkolpuzha	68.15	66.14	74.15	76.25
Perunad	64.16	68.74	78.26	75.6
Mean ±SE	66.426±1.788	66.058±1.678	74.124±2.462	75.346±0.719

Table 1.2.12 : Two way ANOVA showing Sand content of the soil at different study sites during post monsoon and summer season (After flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	17.39063	4	4.347658	1.579893	0.242495	3.259167
Between Samples	364.727	3	121.5757	44.17933	9.26E-07	3.490295
Error	33.02241	12	2.751868			
Total	415.1401	19				

SILT (%)

The value of silt content percentage was 15.36 during November month, 15.44 in December, 10.83 in January and 13.03 during February month. (Table 1.2.13). There is no significant difference in the silt percentage between sites and seasons (P>0.05) (Table 1.2.14).

Table 1.2.13: Silt content of the soil at different study sites during post monsoon and summer season (After flood)

SILT	Post monsoon		Summer	
	November	December	January	February
Ayiroor	15.12	15.96	13.75	12.44
Ranni	14.36	15.29	13.68	13.54
Chettakkal	16.26	15.84	1.36	13.6
Cherkolpuzha	15.85	15.13	12.95	13.05
Perunad	15.2	15	12.45	12.56
Mean ± SE	15.358±0.730	15.444±0.431	10.838±5.325	13.038±0.537

Table 1.2.14 : Two way ANOVA showing Silt content of the soil at different study sites during post monsoon and summer season (After flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	18.78487	4	4.696218	0.571008	0.688822	3.259167
Between Samples	72.08034	3	24.02678	2.921387	0.077434	3.490295
Error	98.69329	12	8.224441			
Total	189.5585	19				

CLAY (%)

The clay percentage was high in post monsoon season followed by summer season. (Table 1.2.15).

Table 1.2.15: Clay content of the soil at different study sites during post monsoon and summer season (After flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Ayiroor	6.23	6.56	5.1	4.98
Ranni	6.84	6.22	5.36	5.12
Chettakkal	6.1	6.84	5.12	5.39
Cherkolpuzha	6.36	6.3	5.36	5.22
Perunad	6.45	6.25	4.98	5.1
Mean ± SE	6.396±0.281	6.434±0.264	5.184±0.169	5.162±0.153

The two way ANOVA result revealed that there is no significant variation in the clay content of various sites ($F=0.503684$, $P>0.05$) and significant variation in the content between seasons ($F=44.86283$, $P<0.05$) (Table 1.2.16).

Table 1.2 : Two way ANOVA showing Clay content of the soil at different study sites during post monsoon and summer season (After flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.11553	4	0.028882	0.503684	0.733983	3.259167
Between Samples	7.71764	3	2.572547	44.86283	8.51E-07	3.490295
Error	0.68811	12	0.057343			
Total	8.52128	19				

NITROGEN (ppm)

The Nitrogen content was 1146.05ppm during November month, 1144.39ppm in December, 1133.59ppm in January and 1134.06ppm during February month. (Table 1.2.17).

Table 1.2.17: Nitrogen content of the soil at different study sites during post monsoon and summer season (After flood)

Sites		Post monsoon		Summer	
		November	December	January	February
Site 1	Ayiroor	1146.23	1130.56	1132.64	
Site 2	Ranni	1143.84	1139.3	1135.64	
Site 3	Chettakkal	1146.3	1132.8	1130	
Site 4	Cherkolpuzha	1145.27	1135.26	1136.98	
Site 5	Perunad	1140.35	1130	1135.05	
Mean ± SE		1146.048±4.289	1144.398±2.471	1133.584±3.810	1134.062±2.761

Two way ANOVA result showed that there is no significant difference in the Nitrogen content between sites ($F=1.486146$, $P>0.05$) and there is difference between seasons ($F=21.07204$, $P<0.05$) (Table 1.2.18)

Table 1.2.18 : Two way ANOVA showing Nitrogen content of the soil at different study sites during post monsoon and summer season (After flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	61.79827	4	15.44957	1.486146	0.267188	3.259167
Between Samples	657.1775	3	219.0592	21.07204	4.49E-05	3.490295
Error	124.7487	12	10.39572			
Total	843.7244	19				

PHOSPHORUS (ppm)

The Phosphorus content almost same with value ranging from an average of 4.29ppm in to 4.45ppm during post monsoon and summer seasons (Table 5.1.1.25). There is no significant difference in the Phosphorus content between sites and seasons ($P>0.05$) (Table 1.2.20)

Table 1.2.19: Phosphorus content of the soil at different study sites during post monsoon and summer season (After flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Ayiroor	4.36	4.23	4.56	4.13
Ranni	4.53	4.3	4.23	4.05
Chettakkal	4.22	4.52	4.25	4.63
Cherkolpuzha	4.36	4.3	4.36	4.59
Perunad	4.02	4.56	4.85	4.33
Mean ±SE	4.298±0.191	4.382±0.147	4.45±0.259	4.346±0.262

Table 1.2.20 : Two way ANOVA showing Phosphorus content of the soil at different study sites during post monsoon and summer season (After flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.047725	3	0.015908	0.365966	0.779391	3.862548
Between Samples	0.001825	3	0.000608	0.013995	0.997568	3.862548
Error	0.391225	9	0.043469			
Total	0.440775	15				

POTASSIUM (ppm)

The Potassium content was high in Post monsoon (64.73ppm) followed by summer (53.75ppm) (Table 1.2.21). There is no significant difference in the Potassium content between sites ($F=0.189829$, $P>0.05$) and there is difference between seasons ($F=24.15559$, $P<0.05$) (Table 1.2.22)

Table 1.2.21: Potassium content of the soil at different study sites during post monsoon and summer season (After flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Ayiroor	65.36	65.38	50.25	54.1
Ranni	63.86	60.22	52.36	55.6
Chettakkal	60.11	68.23	57.23	50.22
Cherkolpuzha	63.5	64.15	52.1	53.64
Perunad	65.84	63.68	53.69	55.2
Mean± SE	63.734±2.251	64.332±2.900	53.126±2.601	53.752±2.128

Table 1.2.22 : Two way ANOVA showing Potassium content of the soil at different study sites during post monsoon and summer season (After flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	5.89958	4	1.474895	0.189829	0.939125	3.259167
Between Samples	563.0379	3	187.6793	24.15559	2.26E-05	3.490295
Error	93.23522	12	7.769602			
Total	662.1727	19				

CALCIUM (ppm)

The Calcium content was an average of 324.27ppm in post monsoon and 309.46ppm during summer season. (Table 1.2.23). There is no significant difference in Calcium content between sites ($F=1.196788$, $P>0.05$) and between seasons there is variation ($F=22.76679$, $P<0.05$) (Table 1.2.24).

Table 1.2.23: Calcium content of the soil at different study sites during post monsoon and summer season (After flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Ayiroor	322.56	316.58	308.26	313.46
Ranni	328.23	325.36	310.22	315.24
Chettakkal	321.3	324.75	314.36	306.84
Cherkolpuzha	325.26	320.11	309.26	303.55
Perunad	324	326.37	305.22	304.3
Mean ±SE	324.27±2.669	322.634±4.149	309.464±3.318	308.678±5.356

Table 1.2.24 : Two way ANOVA showing Calcium content of the soil at different study sites during post monsoon and summer season (After flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	73.05463	4	18.26366	1.196788	0.361706	3.259167
Between Samples	1042.302	3	347.4338	22.76679	3.05E-05	3.490295
Error	183.1267	12	15.26056			
Total	1298.483	19				

MAGNESIUM (ppm)

The Magnesium content was an average of 63.02ppm in post monsoon to 54.96ppm in summer (Table 1.2.25). There is no significant difference in Magnesium content between sites ($F=0.151588$, $P>0.05$) and between seasons there is variation ($F=30.79003$, $P<0.05$) (Table 1.2.26).

Table 1.2.25: Magnesium content of the soil at different study sites during post monsoon and summer season (After flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Ayiroor	62.13	59.23	55.26	56.48
Ranni	63.25	63.19	53.26	53.16
Chettakkal	63	65.44	50.46	57.12
Cherkolpuzha	65.37	62.46	53.58	53.1
Perunad	61.36	63.15	52.33	54.98
Mean ± SE	63.022±1.510	62.694±2.238	52.978±1.761	54.968±1.849

Table 1.2.26 : Two way ANOVA showing Magnesium content of the soil at different study sites during post monsoon and summer season (After flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	2.65782	4	0.664455	0.151588	0.958665	3.259167
Between Samples	404.8853	3	134.9618	30.79003	6.43E-06	3.490295
Error	52.59954	12	4.383295			
Total	460.1427	19				

MOISTURE (%)

The moisture content also varied from an average of 58% in summer to 65% in post monsoon. (Table 1.2.27). There is no significant difference in Moisture content between sites ($F=0.909348$, $P>0.05$) and between seasons there is variation ($F=20.53258$, $P<0.05$) (Table 1.2.28).

Table 1.2.27 : Two way ANOVA showing moisture content of the soil at different study sites during post monsoon and summer season (After flood)

	Post monsoon		Summer	
Sites	November	December	January	February
Ayiroor	65	66	58	60
Ranni	66	65	62	60
Chettakkal	68	65	60	57
Cherkolpuzha	65	64	60	55
Perunad	65	62	61	60
Mean ± SE	65.8±1.303	64.4±1.51	60.2±1.48	58.4±2.30

Table 1.2.28 : Two way ANOVA showing Moisture content of the soil at different study sites during post monsoon and summer season (After flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	10.7	4	2.675	0.909348	0.489243	3.259167
Between Samples	181.2	3	60.4	20.53258	5.11E-05	3.490295
Error	35.3	12	2.941667			
Total	227.2	19				

Fig. 2.1: Mean soil edaphic factors of the study area (Ranni) during summer season (Before flood and after flood)

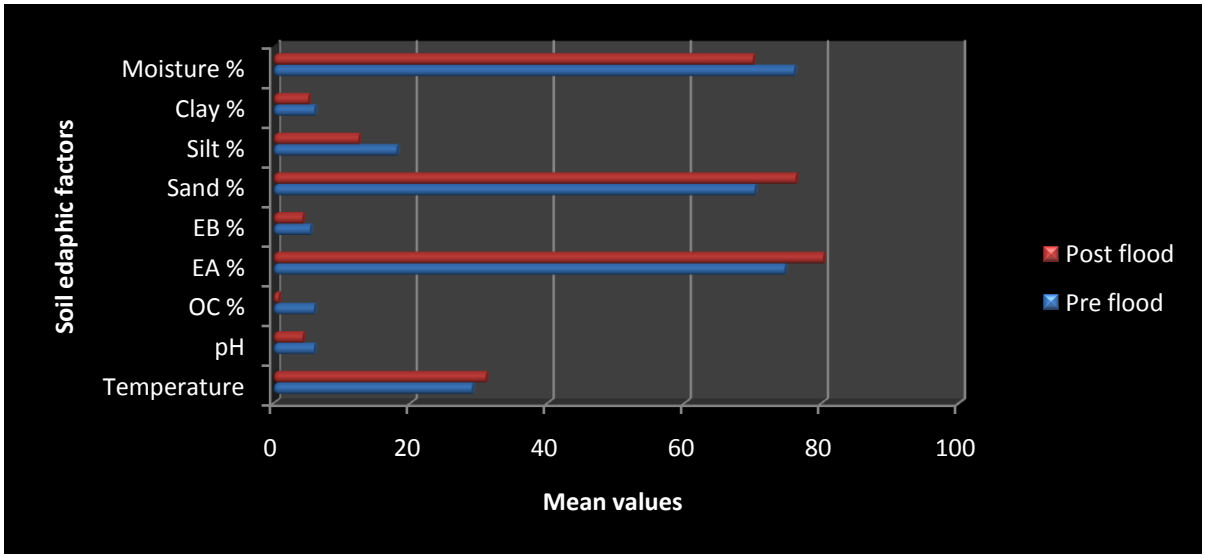
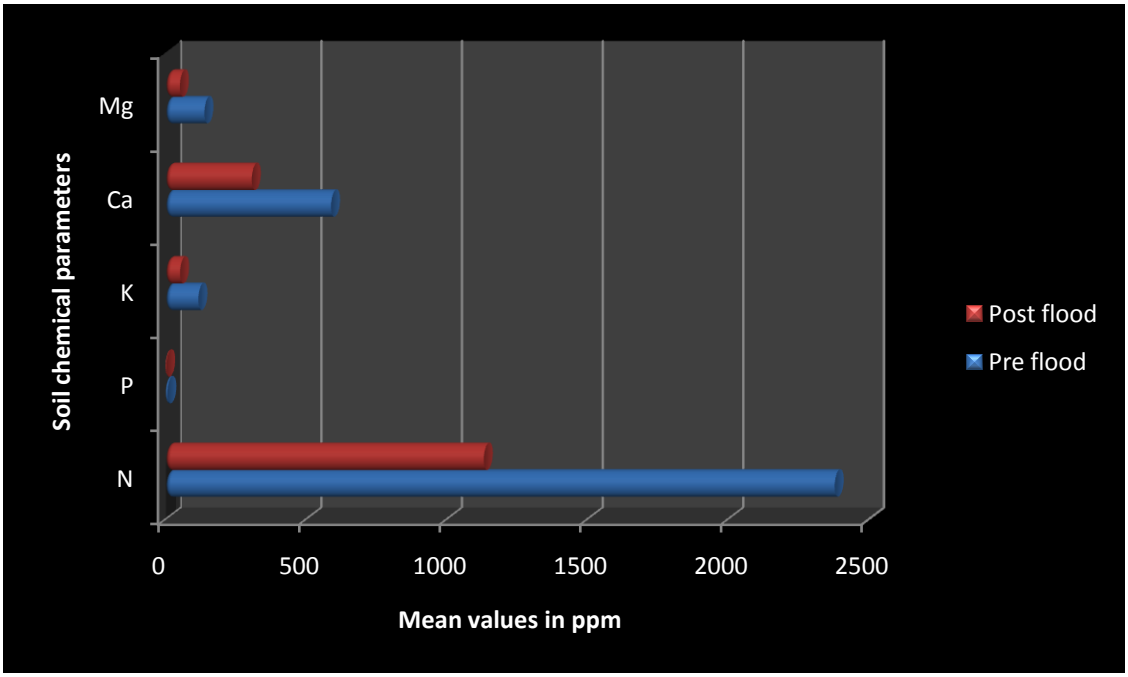


Fig. 2.2: Mean soil chemical factors of the study area (Ranni) during summer season (Before flood and after flood



KOZHENCHERY AREA -BEFORE FLOOD

1.3.1 Soil edaphic and chemical properties in Kozhenchery area before flood

TEMPERATURE (^{0}C)

The mean soil temperature during post monsoon was 27.5 ˚C and 29.6˚C in summer (Table 1.3.1). There is significant variation in soil temperature between months (F=79.19273, P<0.05) and no difference between sites (F=2.619115, P>0.05) (Table 1.3.2)

Table 1.3.1: Temperature of the soil at different study sites during post monsoon and summer season (Before flood)

	Post monsoon		Summer	
Sites	November	December	January	February
Aranmula	27.25	27.15	29.31	29.33
Neervilakom	27.36	27.36	29.36	29.54
Koyipuram	28.16	28.11	30.12	29.36
Arattupuzha	27.25	27.51	29.45	30.06
Malakkara	27	27.56	29.86	29.84
Mean ± SE	27.404±0.442	27.538±0.357	29.62±0.353	29.626±0.316

Table 1.3.2 : Two way ANOVA showing Temperature of the soil at different study sites during post monsoon and summer season (Before flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	1.02307	4	0.255767	2.619115	0.087927	3.259167
Between Samples	23.2005	3	7.7335	79.19273	3.55E-08	3.490295
Error	1.17185	12	0.097654			
Total	25.39542	19				

pH

The pH value ranging from 5.23-5.69 during summer and post monsoon season (Table 1.3.3).

Table 1.3.3: p^H of the soil at different study sites during post monsoon and summer season (Before flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Aranmula	5.78	5.8	5.12	5.16
Neervilakom	5.63	5.52	5.36	4.96
Koyipuram	5.12	5.69	5.2	5.22
Arattupuzha	5.5	5.6	5.33	5.37
Malakkara	5.98	5.87	5.15	5.42
Mean ± SE	5.602±0.323	5.696±0.142	5.232±0.107	5.226±0.182

There is no significant difference in the pH between sites (F=1.279144, P>0.05) and there is difference between seasons (F=7.595439, P<0.05) (Table 1.3.4)

Table 1.3.4 : Two way ANOVA showing p^H of the soil at different study sites during post monsoon and summer season (Before flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.20303	4	0.050758	1.279144	0.331698	3.259167
Between Samples	0.90418	3	0.301393	7.595439	0.004146	3.490295
Error	0.47617	12	0.039681			
Total	1.58338	19				

ORGANIC CARBON (%)

The value of organic carbon percentage was 3.41 during post monsoon and 3.75-3.84 during summer season. (Table 1.3.5). There is no significant difference in the pH between sites (F=0.269057, P>0.05) and there is difference between seasons (F=4.860417, P<0.05) (Table 1.3.6)

Table 1.3.5: Organic carbon content of the soil at different study sites during post monsoon and summer season (Before flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Aranmula	3.4	3.12	4.12	3.65
Neervilakom	3.1	3.66	3.69	3.8
Koyipuram	3.6	3.45	3.85	3.49
Arattupuzha	3.5	3.18	3.64	3.97
Malakkara	3.45	3.64	3.88	3.85
Mean ±SE	3.41±0.188	3.41±0.251	3.836±0.188	3.752±0.186

Table 1.3.6: Two way ANOVA showing Organic carbon content of the soil at different study sites during post monsoon and summer season (Before flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.05572	4	0.01393	0.269057	0.892262	3.259167
Between Samples	0.75492	3	0.25164	4.860417	0.019418	3.490295
Error	0.62128	12	0.051773			
Total	1.43192	19				

EA AND EB (%)

Exchangeable acid value varied from an average of 74.5% in summer to 81.91% in post monsoon. Exchangeable Base value varied from an average of 5.45% in summer to 6.43% in post monsoon (Table 1.3.7 and 1.3.9).

Table 1.3.7: EA of the soil at different study sites during post monsoon and summer season (Before flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Aranmula	80.23	82.16	75.26	72.12
Neervilakom	81.23	83.26	72.36	70.36
Koyipuram	81.65	81.44	74.22	70.26
Arattupuzha	80.23	80.29	76.39	73.69
Malakkara	83.55	82.4	74.29	73.9
Mean ± SE	81.378±1.334	81.91±1.114	74.504±1.487	72.066±1.744

Table 1.3.8 : Two way ANOVA showing EA of the soil at different study sites during post monsoon and summer season (Before flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	7.78517	4	1.946293	0.910115	0.488852	3.259167
Between Samples	364.9316	3	121.6439	56.88246	2.29E-07	3.490295
Error	25.66215	12	2.138512			
Total	398.3789	19				

Table 1.3.9: EB of the soil at different study sites during post monsoon and summer season (Before flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Aranmula	6.32	6.45	5.11	5.16
Neervilakom	6.59	6.22	5.64	5.84
Koyipuram	6.35	6.38	5.39	5.36
Arattupuzha	6.29	6.48	5.48	5.78
Malakkara	6.58	6.13	5.23	5.12
Mean ± SE	6.426±0.146	6.332±0.151	5.37±0.207	5.452±0.339

In both case, there was no difference in values between sites ($P>0.05$) and there is difference between seasons ($P<0.05$) (Table 1.3.8 and 1.3.10).

Table 1.3.10 : Two way ANOVA showing EB of the soil at different study sites during post monsoon and summer season (Before flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.31965	4	0.079912	1.946593	0.167254	3.259167
Between Samples	4.72402	3	1.574673	38.35755	1.99E-06	3.490295
Error	0.49263	12	0.041053			
Total	5.5363	19				

SAND (%)

The sand percentage was high in summer season with an average of 74.93% followed by post monsoon (63.58%). (Table 1.3.11).

Table 1.3.11: Sand content of the soil at different study sites during post monsoon and summer season (Before flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Aranmula	62.35	62.35	71.23	75.46
Neervilakom	60.06	60.16	75.36	72.31
Koyipuram	60.35	64.85	73.26	70.26
Arattupuzha	62.36	67.36	78.45	73.68
Malakkara	62.48	63.22	76.36	75.26
Mean ± SE	61.52±1.205	63.588±2.713	74.932±2.78	73.394±2.16

The two way ANOVA result revealed that there is no significant variation in the sand content of various sites ($F=2.180071$, $P>0.05$) and significant variation in the content between seasons ($F=56.1133$, $P<0.05$) (Table 1.3.12).

Table 1.3.12 : Two way ANOVA showing Sand content of the soil at different study sites during post monsoon and summer season (Before flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	35.76643	4	8.941608	2.180071	0.133012	3.259167
Between Samples	690.4496	3	230.1499	56.1133	2.47E-07	3.490295
Error	49.21825	12	4.101521			
Total	775.4343	19				

SILT (%)

The value of silt content percentage was 22.96 during November month, 26.02 in December, 17.34 in January and 16.67 during February month. (Table 1.3.13). There is no significant difference in the silt percentage between sites ($F=0.531481$, $P>0.05$) and there is difference between seasons ($F=39.96946$, $P<0.05$) (Table 1.3.14)

Table 1.3.13: Silt content of the soil at different study sites during post monsoon and summer season (Before flood)

	Post monsoon		Summer	
Sites	November	December	January	February
Aranmula	22.12	26.35	16.39	16.07
Neervilakom	22.36	24.13	18.25	18.23
Koyipuram	22.45	26.26	14.26	17.52
Arattupuzha	23.29	28.13	18.16	15.23
Malakkara	24.58	25.23	19.66	16.31
Mean ± SE	22.96±1.073	26.02±1.484	17.344±2.078	16.672±1.195

Table 1.3.14 : Two way ANOVA showing Silt content of the soil at different study sites during post monsoon and summer season (Before flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	5.39758	4	1.349395	0.531481	0.715192	3.259167
Between Samples	304.4396	3	101.4799	39.96946	1.6E-06	3.490295
Error	30.46722	12	2.538935			
Total	340.3044	19				

CLAY (%)

The clay percentage was high in post monsoon season followed by summer season. (Table 1.3.15). The two way ANOVA result revealed that there is no significant variation in the clay content of various sites ($F=0.390114$, $P>0.05$) and significant variation in the content between seasons ($F=35.17632$, $P<0.05$) (Table 1.3.16).

Table 1.3: Clay content of the soil at different study sites during post monsoon and summer season (Before flood)

	Post monsoon		Summer	
Sites	November	December	January	February
Aranmula	7.25	7.16	5.13	5.56
Neervilakom	7.36	7.33	5.26	5.84
Koyipuram	8.26	7.85	5.19	5.26
Arattupuzha	7.45	7.56	5.46	5.68
Malakkara	7.22	7.16	6.38	5.13
Mean ± SE	7.508±0.431	7.412±0.295	5.484±0.516	5.494±0.294

Table 1.2 : Two way ANOVA showing Clay content of the soil at different study sites during post monsoon and summer season (Before flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.28757	4	0.071893	0.390114	0.811788	3.259167
Between Samples	19.4475	3	6.482498	35.17632	3.17E-06	3.490295
Error	2.21143	12	0.184286			
Total	21.9465	19				

NITROGEN (ppm)

The Nitrogen content was 2420ppm during November month, 2428ppm in December, 2482ppm in January and 2471ppm during February month. (Table 1.3.17). There is no significant difference in the Nitrogen content between sites (F=0.478632, P>0.05) and there is difference between seasons (F=16.83542, P<0.05) (Table 1.3.18)

Table 1.3.17: Nitrogen content of the soil at different study sites during post monsoon and summer season (Before flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Aranmula	2428.36	2438.55	2462.36	2459.31
Neervilakom	2436.16	2458.23	2483.68	2461.03
Koyipuram	2416.19	2421.23	2498.06	2477.31
Arattupuzha	2405.36	2416.34	2476.1	2497.13
Malakkara	2415.3	2408.36	2492.46	2464.33
Mean ± SE	2420.274±12.051	2428.542±19.944	2482.532±14.047	2471.822±15.804

Table 1.3.18 : Two way ANOVA showing Nitrogen content of the soil at different study sites during post monsoon and summer season (Before flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	545.1183	4	136.2796	0.478632	0.751053	3.259167
Between Samples	14380.5	3	4793.499	16.83542	0.000134	3.490295
Error	3416.724	12	284.727			
Total	18342.34	19				

PHOSPHORUS (ppm)

The Phosphorus content was high in Post monsoon (7.43ppm) and low in summer (6.50ppm) (Table 1.3.19). There is no significant difference in the Phosphorus content between sites (F=0.221047, P>0.05) and there is difference between seasons (F=20.24985, P<0.05) (Table 1.3.20)

Table 1.3.19: Phosphorus content of the soil at different study sites during post monsoon and summer season (Before flood)

Sites	Post monsoon		Summer	
	November	December	January	5.84
Aranmula	7.12	7.86	6.38	6.13
Neervilakom	7.26	7.26	6.31	6.39
Koyipuram	7.45	7.19	6.69	6.59
Arattupuzha	7.36	7.54	5.98	6.54
Malakkara	7.06	7.33	6.16	6.87
Mean ± SE	7.25±0.1621	7.436±0.271	6.30±0.265	6.504±0.272

Table 1.3.20 : Two way ANOVA showing Phosphorus content of the soil at different study sites during post monsoon and summer season (Before flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.06688	4	0.01672	0.221047	0.921519	3.259167
Between Samples	4.595095	3	1.531698	20.24985	5.47E-05	3.490295
Error	0.90768	12	0.07564			
Total	5.569655	19				

POTASSIUM (ppm)

The Potassium content was high in Post monsoon (147.42ppm) followed by summer (127.06ppm) (Table 1.3.21). There is no significant difference in the Potassium content between sites ($F=0.795774$, $P>0.05$) and there is difference between seasons ($F=46.35101$, $P<0.05$) (Table 1.3.22)

Table 1.3.21: Potassium content of the soil at different study sites during post monsoon and summer season (Before flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Aranmula	148.56	146.38	122.36	127.25
Neervilakom	152.36	140.57	120.45	129.36
Koyipuram	142.39	146.37	129.36	124.2
Arattupuzha	140.36	143.47	124.25	126.24
Malakkara	153.46	145.54	126.33	128.26
Mean ± SE	147.426±5.859	144.466±2.481	124.55±3.464	127.062±1.976

Table 1.3.22 : Two way ANOVA showing Potassium content of the soil at different study sites during post monsoon and summer season (Before flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	47.28823	4	11.82206	0.795774	0.550335	3.259167
Between Samples	2065.777	3	688.5925	46.35101	7.12E-07	3.490295
Error	178.2725	12	14.85604			
Total	2291.338	19				

CALCIUM (ppm)

The Calcium content was an average of 649ppm in post monsoon and 626 ppm during summer season. (Table 1.3.23). There is no significant difference in Calcium content between sites ($F=0.055596$, $P>0.05$) and between seasons there is variation ($F=23.47318$, $P<0.05$) (Table 1.3.24).

Table 1.3.23: Calcium content of the soil at different study sites during post monsoon and summer season (Before flood)

	Post monsoon		Summer	
Sites	November	December	January	February
Aranmula	642.35	645.23	622.34	634.2
Neervilakom	652.36	649.26	623.16	624.26
Koyipuram	649.32	645.45	626.23	629.1
Arattupuzha	658.16	643.11	625.49	618.39
Malakkara	646.94	643.13	634.16	620.33
Mean ± SE	649.826±5.924	645.236±2.508	626.276±4.689	625.256±6.464

Table 1.3.24 : Two way ANOVA showing Calcium content of the soil at different study sites during post monsoon and summer season (Before flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	7.65448	4	1.91362	0.055596	0.993458	3.259167
Between Samples	2423.847	3	807.9491	23.47318	2.61E-05	3.490295
Error	413.0412	12	34.4201			
Total	2844.543	19				

MAGNESIUM (ppm)

The Magnesium content was an average of 137ppm in post monsoon to 125ppm in summer (Table 1.3.25). There is no significant difference in Magnesium content between sites ($F=1.694888$, $P>0.05$) and between seasons there is variation ($F=25.28782$, $P<0.05$) (Table 1.3.26).

Table 1.3.25: Magnesium content of the soil at different study sites during post monsoon and summer season (Before flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Aranmula	135.26	136.48	122.54	122.56
Neervilakom	139.1	135.1	123.3	123.15
Koyipuram	135.15	142.33	129.45	129.45
Arattupuzha	140.26	139.54	126.24	123.5
Malakkara	139.16	130.64	120.4	128.15
Mean ±SE	137.786±2.401	136.818±4.445	124.386±3.519	125.362±3.189

Table 1.3.26 : Two way ANOVA showing Magnesium content of the soil at different study sites during post monsoon and summer season (Before flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	69.43677	4	17.35919	1.694888	0.215523	3.259167
Between Samples	776.9999	3	259	25.28782	1.79E-05	3.490295
Error	122.905	12	10.24209			
Total	969.3417	19				

MOISTURE (%)

The moisture content also varied from an average of 72% in summer to 78% in post monsoon. (Table 1.3.27). There is no significant difference in Moisture content between sites ($F=1.878049$, $P>0.05$) and between seasons there is variation ($F=31.60976$, $P<0.05$) (Table 1.3.28).

Table 1.3.27 : Two way ANOVA showing moisture content of the soil at different study sites during post monsoon and summer season (Before flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Aranmula	75	75	70	70
Neervilakom	75	75	72	73
Koyipuram	75	76	71	71
Arattupuzha	74	75	71	70
Malakkara	78	76	70	72
Mean ±SE	75.4 ±1.35	75.4 ±0.48	70.8 ±0.73	71.2 ±1.16

Table 1.3.28 : Two way ANOVA showing moisture content of the soil at different study sites during post monsoon and summer season (Before flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	7.7	4	1.925	1.878049	0.179093	3.259167
Between Samples	97.2	3	32.4	31.60976	5.6E-06	3.490295
Error	12.3	12	1.025			
Total	117.2	19				

Fig. 3.1: Mean soil edaphic factors of the study area (Kozhencherry) during post monsoon season (Before flood and after flood)

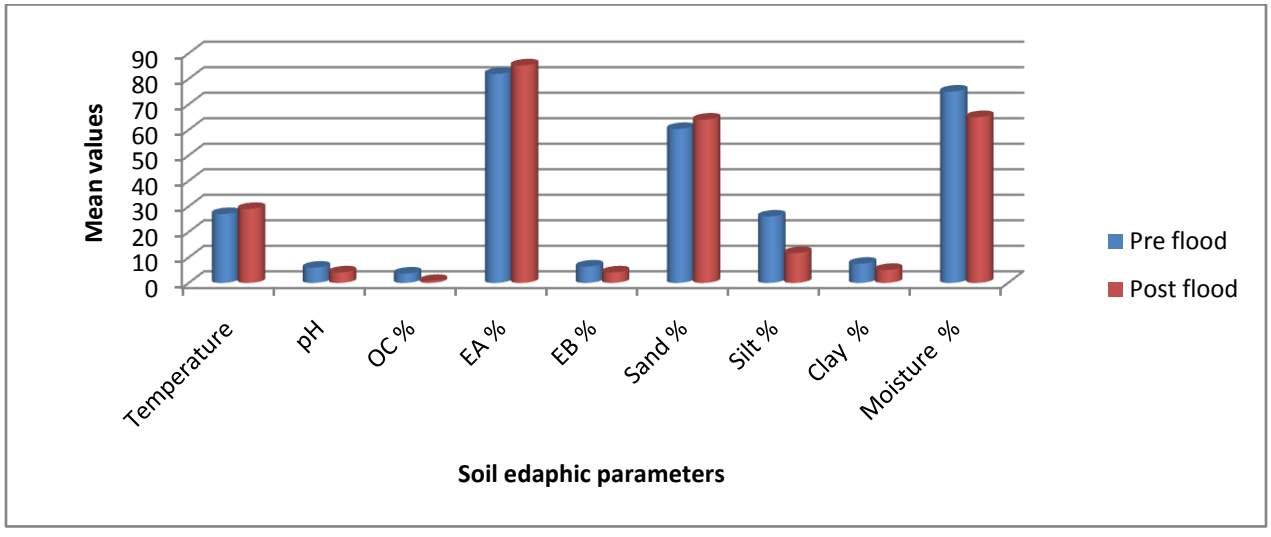
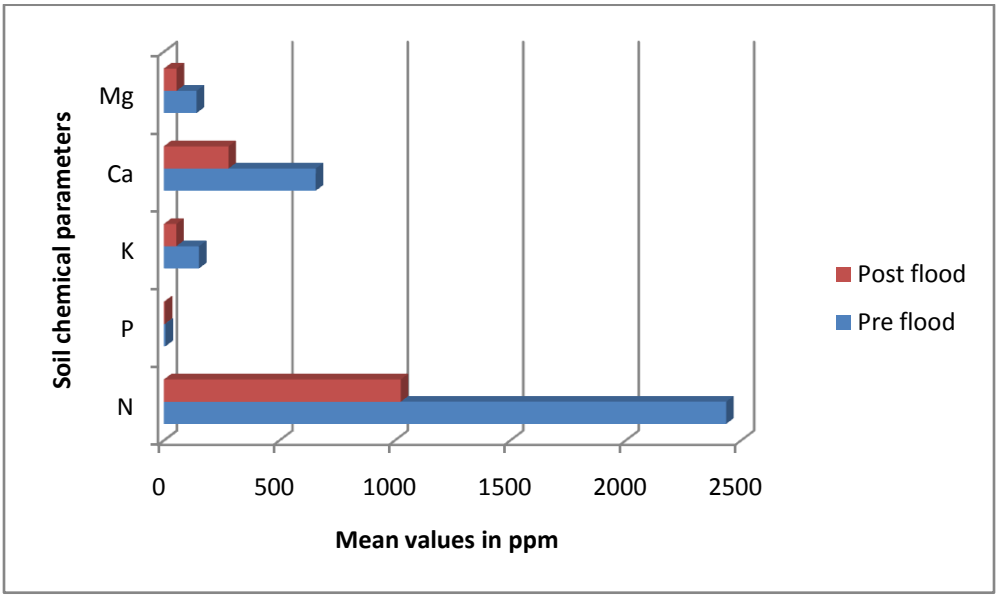


Fig. 3.2: Mean soil chemical factors of the study area (Kozhenchery) during post monsoon season (Before flood and after flood)



KOZHENCHERRY AREA - AFTER FLOOD

1.4.2 Soil edaphic and chemical properties in Kozhencherry area after flood

TEMPERATURE (^{0}C)

The mean soil temperature during November month was 29.1˚C, 28.9˚C in December. 30.2˚C in January and 30.2˚C in February (Table 1.4.1).

Table 1.4.1: Temperature of the soil at different study sites during post monsoon and summer season (After flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Aranmula	28.2	29	30.25	29.85
Neervilakom	29.6	28.5	30.26	30.15
Koyipuram	28.6	28.4	30.58	30.68
Arattupuzha	29.5	29.36	30.15	30.16
Malakkara	29.6	29.5	30	30.2
Mean ± SE	29.1 ±0.655	28.952 ±0.494	30.248 ±0.213	30.208 ±0.298

There is significant variation in soil temperature between months (F=11.24897, P<0.05) and no difference between sites (F=0.749018, P>0.05) (Table 1.4.2).

Table 1.4.2 : Two way ANOVA showing Temperature of the soil at different study sites during post monsoon and summer season (After flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.64657	4	0.161643	0.749018	0.577294	3.259167
Between Samples	7.28278	3	2.427593	11.24897	0.000841	3.490295
Error	2.58967	12	0.215806			
Total	10.51902	19				

pH

The pH value was high in post monsoon season (4.44) followed by summer season (3.62) (Table 1.4.3). There is no significant difference in the pH between sites F=0.158219 P>0.05 and significant difference in the pH between season F=18.6866, P>0.05 (Table 1.4.4)

Table 1.4.3: pH of the soil at different study sites during post monsoon and summer season (After flood)

	Post monsoon		Summer	
Sites	November	December	January	February
Aranmula	4.25	4.55	3.56	3.6
Neervilakom	4.12	4.85	3.58	3.48
Koyipuram	4.26	4.36	3.68	3.5
Arattupuzha	4.35	4.16	3.45	3.76
Malakkara	4.85	4.3	3.26	3.82
Mean ± SE	4.366±0.283	4.444±0.267	3.506±0.159	3.632±0.153

Table 1.4.4 : Two way ANOVA showing pH of the soil at different study sites during post monsoon and summer season (After flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.04007	4	0.010017	0.158219	0.955461	3.259167
Between Samples	3.54938	3	1.183127	18.6866	8.12E-05	3.490295
Error	0.75977	12	0.063314			
Total	4.34922	19				

ORGANIC CARBON (%)

The value of organic carbon percentage was 0.84 during post monsoon and 0.75 during summer season. (Table 1.4.5).

Table 1.4.5: Organic carbon content of the soil at different study sites during post monsoon and summer season (After flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Aranmula	0.85	0.8	0.74	0.75
Neervilakom	0.86	0.84	0.78	0.72
Koyipuram	0.84	0.85	0.76	0.79
Arattupuzha	0.83	0.8	0.78	0.78
Malakkara	0.85	0.87	0.7	0.7
Mean ± SE	0.846±0.112	0.832±0.0312	0.752±0.0334	0.748±0.038

There is no significant difference in the pH between sites ($F=0.559486$, $P>0.05$) and there is difference between seasons ($F=12.90514$, $P<0.05$) (Table 1.4.6)

Table 1.4.6 : Two way ANOVA showing Organic carbon content of the soil at different study sites during post monsoon and summer season (After flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.00232	4	0.00058	0.559486	0.696461	3.259167
Between Samples	0.040135	3	0.013378	12.90514	0.000459	3.490295
Error	0.01244	12	0.001037			
Total	0.054895	19				

EA AND EB (%)

Exchangeable acid value varied from an average of 85.27% in post monsoon to 75.8% in summer. Exchangeable Base value varied from an average of 4.9% in summer to 4.3% in post monsoon (Table 1.4.7 and 1.4.9). In both case, there was no difference in values between sites ($P>0.05$) and there is difference between seasons ($P<0.05$) (Table 1.4.8 and 1.4.10).

Table 1.4.7: EA of the soil at different study sites during post monsoon and summer season (After flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Aranmula	85.16	85.31	75.16	76.35
Neervilakom	84.26	85.46	75.12	74.25
Koyipuram	82.36	85.1	75.68	78.26
Arattupuzha	85.69	86.15	75.12	75.25
Malakkara	84.22	84.33	75.23	75.34
Mean ± SE	84.338±1.268	85.27±0.656	75.262±0.237	75.89±1.519

Table 1.4.8 : Two way ANOVA showing EA of the soil at different study sites during post monsoon and summer season (After flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	2.36975	4	0.592438	0.466253	0.759524	3.259167
Between Samples	428.9374	3	142.9791	112.5258	4.73E-09	3.490295
Error	15.24761	12	1.270634			
Total	446.5548	19				

Table 1.4.9: EB of the soil at different study sites during post monsoon and summer season (After flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Aranmula	4.12	4.16	4.25	5.12
Neervilakom	4.58	4.86	5.13	5.85
Koyipuram	4.26	4.22	4.55	4.26
Arattupuzha	4.11	4.16	4.68	4.87
Malakkara	4.36	4.24	4.57	4.69
Mean ± SE	4.286±0.194	4.328±0.299	4.636±0.318	4.958±0.589

Table 1.4.10 : Two way ANOVA showing EB of the soil at different study sites during post monsoon and summer season (After flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	1.57967	4	0.394918	6.52999	0.004974	3.259167
Between Samples	1.46412	3	0.48804	8.069778	0.003286	3.490295
Error	0.72573	12	0.060478			
Total	3.76952	19				

SAND (%)

The sand percentage with an average of 62.48% in post monsoon followed by 69.86% during summer (Table 1.4.11). The two way ANOVA result revealed that there is no significant variation in the sand content of various sites ($F=0.690324$, $P>0.05$) and significant variation in the content between seasons ($F=39.33462$, $P<0.05$) (Table 1.2.12).

Table 1.4.11: Sand content of the soil at different study sites during post monsoon and summer season (After flood)

	Post monsoon		Summer	
Sites	November	December	January	February
Aranmula	62.34	63.45	68.25	69.34
Neervilakom	62.15	62.55	70.32	68.15
Koyipuram	63.56	61.26	69.26	65.26
Arattupuzha	60.45	61.15	71.25	67.26
Malakkara	61.22	64.03	70.22	69.34
Mean ± SE	61.944±1.179	62.488±1.285	69.86±1.142	67.87±1.701

Table 1.4.12 : Two way ANOVA showing Sand content of the soil at different study sites during post monsoon and summer season (After flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	5.42147	4	1.355367	0.690324	0.612581	3.259167
Between Samples	231.6861	3	77.2287	39.33462	1.74E-06	3.490295
Error	23.56053	12	1.963378			
Total	260.6681	19				

SILT (%)

The value of silt content percentage was 11.97 during November month, 11.96 in December, 10.21 in January and 9.6 during February month. (Table 1.4.13). There is no significant difference in the silt percentage between sites and seasons (P>0.05) (Table 1.4.14).

Table 1.4.13: Silt content of the soil at different study sites during post monsoon and summer season (After flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Aranmula	12.35	10.55	10.22	9.26
Neervilakom	11.26	12.64	10.36	9.4
Koyipuram	10.35	13.85	10.58	10.45
Arattupuzha	12.38	12.45	9.64	9.58
Malakkara	13.54	10.33	10.28	9.33
Mean ± SE	11.976±1.215	11.964±1.493	10.216±0.349	9.604±0.487

Table 1.4.14 : Two way ANOVA showing Silt content of the soil at different study sites during post monsoon and summer season (After flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	1.05945	4	0.264863	0.209016	0.928458	3.259167
Between Samples	22.15472	3	7.384907	5.827801	0.01075	3.490295
Error	15.20623	12	1.267186			
Total	38.4204	19				

CLAY (%)

The clay percentage was high in summer season followed by post monsoon season (Table 1.4.15).

Table 1.4.15: Clay content of the soil at different study sites during post monsoon and summer season (After flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Aranmula	5.23	4.85	6.23	6.26
Neervilakom	5.15	5.12	6.54	6.34
Koyipuram	4.25	5.36	6.26	5.25
Arattupuzha	5.36	5.48	5.85	6.38
Malakkara	5.98	4.68	6.13	6.45
Mean ±SE	5.194±0.621	5.098±0.335	6.202±0.247	6.136±0.5003

The two way ANOVA result revealed that there is no significant variation in the clay content of various sites (F=0.951681, P>0.05) and significant variation in the content between seasons (F=8.568239, P<0.05) (Table 1.4.16).

Table 1.4.16 : Two way ANOVA showing Clay content of the soil at different study sites during post monsoon and summer season (After flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.77995	4	0.194988	0.951681	0.46807	3.259167
Between Samples	5.266575	3	1.755525	8.568239	0.002598	3.490295
Error	2.45865	12	0.204888			
Total	8.505175	19				

NITROGEN (ppm)

The Nitrogen content was 1026.93ppm during November month, 1030.78ppm in December, 1013.93ppm in January and 1009.87ppm during February month. (Table 1.4.17). Two way ANOVA result showed that there is no significant difference in the Nitrogen content between sites (F=0.366036, P>0.05) and there is difference between seasons (F=11.5701, P<0.05) (Table 1.4.18)

Table 1.4.17: Nitrogen content of the soil at different study sites during post monsoon and summer season (After flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Aranmula	1022.36	1031.26	1008.26	1009.16
Neervilakom	1026.34	1026.2	1006.3	1024.35
Koyipuram	1029.36	1034.33	1015.23	1001.2
Arattupuzha	1030.28	1028.12	1016.23	1005.34
Malakkara	1026.34	1034	1023.65	1009.31
Mean ± SE	1026.936±3.111	1030.782±3.579	1013.934±6.925	1009.872±8.748

Table 1.4.18 : Two way ANOVA showing Nitrogen content of the soil at different study sites during post monsoon and summer season (After flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	63.93753	4	15.98438	0.366036	0.828222	3.259167
Between Samples	1515.759	3	505.2529	11.5701	0.000744	3.490295
Error	524.0261	12	43.66884			
Total	2103.722	19				

PHOSPHORUS (ppm)

The Phosphorus content value ranging from an average of 3.51ppm in to 4.55ppm during summer seasons to post monsoon (Table 1.4.19). There is no significant difference in the Phosphorus content between sites and seasons (P>0.05) (Table 1.4.20)

Table 1.4.19: Phosphorus content of the soil at different study sites during post monsoon and summer season (After flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Aranmula	4.55	4.68	3.15	3.55
Neervilakom	4.25	4.26	3.68	3.69
Koyipuram	4.36	4.98	3.45	3.14
Arattupuzha	4.85	4.48	3.69	3.58
Malakkara	4.29	4.36	3.45	3.6
Mean ± SE	4.46±0.245	4.552±0.287	3.484±0.220	3.512±0.214

Table 1.4.20 : Two way ANOVA showing Phosphorus content of the soil at different study sites during post monsoon and summer season (After flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.11847	4	0.029618	0.428097	0.785718	3.259167
Between Samples	5.10344	3	1.701147	24.58867	2.06E-05	3.490295
Error	0.83021	12	0.069184			
Total	6.05212	19				

POTASSIUM (ppm)

The Potassium content was high in Post monsoon (56.46ppm) followed by summer (44.53ppm) (Table 1.4.21).There is no significant difference in the Potassium content between sites ($F=0.064506$, $P>0.05$) and there is difference between seasons ($F=25.96179$, $P<0.05$) (Table 1.4.22)

Table 1.4.21: Potassium content of the soil at different study sites during post monsoon and summer season (After flood)

	Post monsoon		Summer	
Sites	November	December	January	February
Aranmula	55.26	56.34	43.68	42.36
Neervilakom	53.26	56.98	41.23	45.95
Koyipuram	56.68	57.25	42.33	43.6
Arattupuzha	54.1	53.26	40.58	48.45
Malakkara	50.37	58.48	48.36	42.33
Mean ± SE	53.934±2.371	56.462±1.952	43.236±3.065	44.538±2.636

Table 1.4.22 : Two way ANOVA showing Potassium content of the soil at different study sites during post monsoon and summer season (After flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	2.1862	4	0.54655	0.064506	0.991328	3.259167
Between Samples	659.9086	3	219.9695	25.96179	1.56E-05	3.490295
Error	101.6738	12	8.472817			
Total	763.7686	19				

CALCIUM (ppm)

The Calcium content was an average of 282.53ppm in post monsoon and 265.21ppm during summer season. (Table 1.4.23). There is no significant difference in Calcium content between sites ($F=0.216904$, $P>0.05$) and between seasons there is variation ($F=29.92341$, $P<0.05$) (Table 1.4.24).

Table 1.4.23: Calcium content of the soil at different study sites during post monsoon and summer season (After flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Aranmula	288.51	278.26	265.38	259.34
Neervilakom	280.68	280.6	263.45	262.37
Koyipuram	281.36	286.46	260.85	265.28
Arattupuzha	286.45	277.35	269.3	254.26
Malakkara	275.68	280	267.1	260.34
Mean ± SE	282.536±5.071	280.534±3.561	265.216±3.258	260.318±4.077

Table 1.4.24 : Two way ANOVA showing Calcium content of the soil at different study sites during post monsoon and summer season (After flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	17.69813	4	4.424533	0.216904	0.923929	3.259167
Between Samples	1831.185	3	610.395	29.92341	7.47E-06	3.490295
Error	244.7829	12	20.39858			
Total	2093.666	19				

MAGNESIUM (ppm)

The Magnesium content was an average of 56ppm in post monsoon to 45ppm in summer (Table 1.4.25). There is no significant difference in Magnesium content between sites

(F=1.516162, P>0.05) and between seasons there is variation (F=37.69173, P<0.05) (Table 1.4.26).

Table 1.4.25: Magnesium content of the soil at different study sites during post monsoon and summer season (After flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Aranmula	52.37	53.48	42.38	45.58
Neervilakom	55.69	54.86	45.68	43.18
Koyipuram	54.16	59.65	45.8	47.33
Arattupuzha	58.49	58.47	40.36	42.1
Malakkara	56.15	57.1	47.85	46.84
Mean± SE	55.372±2.287	56.712±2.537	44.414±2.666	45.006±2.285

Table 1.4.26 : Two way ANOVA showing Magnesium content of the soil at different study sites during post monsoon and summer season (After flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	34.72443	4	8.681108	1.516162	0.259	3.259167
Between Samples	647.4363	3	215.8121	37.69173	2.19E-06	3.490295
Error	68.70857	12	5.725714			
Total	750.8693	19				

MOISTURE (%)

The moisture content also varied from an average of 60% in summer to 65% in post monsoon. (Table 1.4.27). There is no significant difference in Moisture content between sites (F=3.166667, P>0.05) and between seasons there is variation (F=25.93056, P<0.05) (Table 1.4.28).

Table 1.4.27: Moisture content of the soil at different study sites during post monsoon and summer season (After flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Aranmula	67	66	60	61
Neervilakom	66	65	62	60
Koyipuram	66	67	61	62
Arattupuzha	65	64	60	61
Malakkara	63	62	61	60
Mean±SE	65.4±1.52	64.8±1.92	60.8±0.83	60.8±0.83

Table 1.4.28 : Two way ANOVA showing moisture content of the soil at different study sites during post monsoon and summer season (After flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	15.2	4	3.8	3.166667	0.0541	3.259167
Between Samples	93.35	3	31.11667	25.93056	1.57E-05	3.490295
Error	14.4	12	1.2			
Total	122.95	19				

Fig.4.1: Mean soil edaphic factors of the study area (Kozhenchery) during summer season (Before flood and after flood

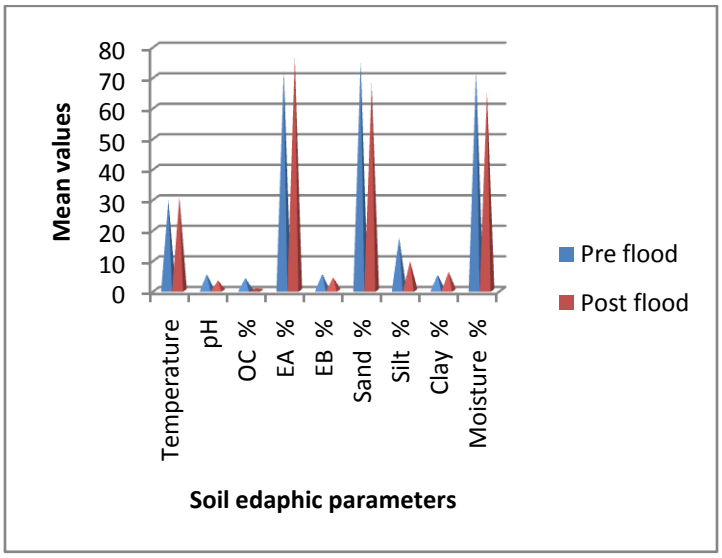
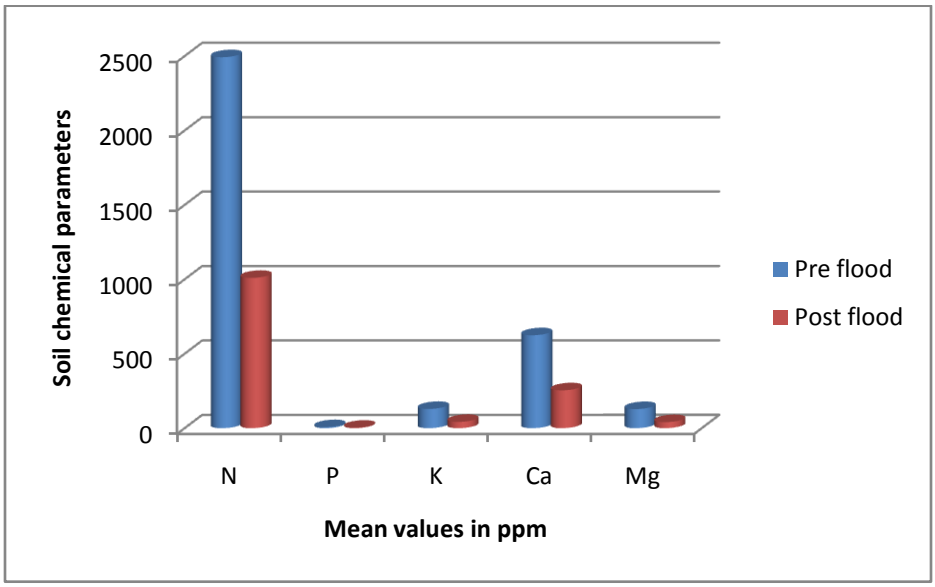


Fig.4.2: Mean soil chemical factors of the study area (Kozhenchery) during summer season (Before flood and after flood



CHENGANNUR- BEFORE FLOOD

1.5.1 Soil edaphic and chemical properties in Chengannur area before flood

TEMPERATURE (^{0}C)

The mean soil temperature during November month was 27.9˚C, December month was 28˚C, 30˚C in January and February (Table 1.5.1). There is significant variation in soil temperature between months ($F=1.883801$, $P<0.05$) and no difference between sites ($F=52.61133$, $P>0.05$) (Table 1.5.2).

Table 1.5.1: Temperature of the soil at different study sites during post monsoon and summer season (Before flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Chengannur	27.5	27.8	30.5	30.8
Pandanad	27.8	28.4	30.5	30.1
Thiruvanvandoor	28.3	28.2	29.5	29.7
Venmony	27.6	27.6	29.8	29.8
Ala panchayath	28.4	28.4	30.2	30.5
Mean ±SE	27.92±0.408	28.08±0.363	30.1±0.442	30.18±0.466

Table 1.5.2 : Two way ANOVA showing Temperature of the soil at different study sites during post monsoon and summer season (Before flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	1.097	4	0.27425	1.883801	0.178065	3.259167
Between Samples	22.978	3	7.659333	52.61133	3.54E-07	3.490295
Error	1.747	12	0.145583			
Total	25.822	19				

pH

The pH value was almost same in all months with an average of 6.5. (Table 1.5.3). There is no significant difference in the pH between sites $F=0.522552$, $P>0.05$ and significant variation between seasons $F=6.84062$, $P<0.05$) (Table 1.5.4)

Table 1.5.3: pH the soil at different study sites during post monsoon and summer season (Before flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Chengannur	6.23	6.22	6.52	6.55
Pandanad	6.11	6.34	6.58	6.89
Thiruvanvandoor	6.05	6.2	6.98	6.45
Venmony	6.45	6.4	6.45	6.9
Ala panchayath	6.35	6.15	6.36	6.7
Mean ±SE	6.238±0.065	6.262±0.104	6.578±0.239	6.698±0.201

Table 1.5.4 : Two way ANOVA showing pH of the soil at different study sites during post monsoon and summer season (Before flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.08048	4	0.02012	0.522552	0.721208	3.259167
Between Samples	0.79016	3	0.263387	6.84062	0.006116	3.490295
Error	0.46204	12	0.038503			
Total	1.33268	19				

ORGANIC CARBON (%)

The value of organic carbon percentage was almost same in all months with an average of 4.5. (Table 1.5.5). There is no significant difference in the pH between sites ($F=0.96235$, $P>0.05$) and there is difference between seasons ($F=11.68671$, $P<0.05$) (Table 1.5.6)

Table 1.3: Organic carbon content of the soil at different study sites during post monsoon and summer season (Before flood)

	Post monsoon		Summer	
Sites	November	December	January	February
Chengannur	4.5	4.88	4.23	4.4
Pandanad	4.8	4.69	4.1	4.1
Thiruvanvandoor	4.69	4.8	4.06	4.3
Venmony	4.76	4.69	4.4	4.56
Ala panchayath	4.36	4.59	4.25	4.46
Mean ± SE	4.622±0.186	4.73±0.112	4.208±0.135	4.364±0.175

Table 1.5.6 : Two way ANOVA showing Organic carbon content of the soil at different study sites during post monsoon and summer season (Before flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.09338	4	0.023345	0.96235	0.462869	3.259167
Between Samples	0.8505	3	0.2835	11.68671	0.000712	3.490295
Error	0.2911	12	0.024258			
Total	1.23498	19				

EA AND EB (%)

Exchangeable acid value varied from an average of 69.3% in summer to 77.2% in post monsoon. Exchangeable Base value varied from an average of 6.5% in summer to 7.7% in post monsoon (Table 1.5.7 and 1.5.9).

Table 1.5.7: EA of the soil at different study sites during post monsoon and summer season (Before flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Chengannur	75.36	76.5	69.36	73.36
Pandanad	78.56	75.26	72.25	71.2
Thiruvanvandoor	80.25	75	71.23	69.4
Venmony	72.36	75.48	68.65	68.4
Ala panchayath	79.6	75.6	65.26	72.33
Mean ± SE	77.226±3.306	75.568±0.568	69.35±2.701	70.938±2.042

Table 1.5.8 : Two way ANOVA showing EA of the soil at different study sites during post monsoon and summer season (Before flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	23.70157	4	5.925392	1.058813	0.418269	3.259167
Between Samples	208.6768	3	69.55894	12.42954	0.000543	3.490295
Error	67.15511	12	5.596259			
Total	299.5335	19				

Table 1.5.9: EB of the soil at different study sites during post monsoon and summer season (Before flood)

EB	Post monsoon		Summer	
	November	December	January	February
Chengannur	7.26	7.85	6.26	6.45
Pandanad	7.58	7.88	6.45	6.55
Thiruvanvandoor	7.36	7.63	6.99	6.12
Venmony	7.12	7.49	6.32	6.38
Ala panchayath	7.59	7.9	6.48	6.15
Mean ±SE	7.382±0.204	7.75±0.181	6.5±0.288	6.33±0.188

In both case, there was no difference in values between sites (P>0.05) and there is difference between seasons (P<0.05) (Table 1.5.8 and 1.5.10).

Table 1.5.10: Two way ANOVA showing EB of the soil at different study sites during post monsoon and summer season (Before flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.18432	4	0.04608	0.939833	0.47391	3.259167
Between Samples	7.034815	3	2.344938	47.8266	5.99E-07	3.490295
Error	0.58836	12	0.04903			
Total	7.807495	19				

SAND (%)

The sand percentage with an average of 65.34% in post monsoon followed by 73.5% during summer (Table 1.5.11).

Table 1.5.11: Sand content of the soil at different study sites during post monsoon and summer season (Before flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Chengannur	66.35	64.15	73.36	70.22
Pandanad	65.26	63.25	75.36	75.36
Thiruvanvandoor	68.45	68.69	70.39	74.26
Venmony	61.26	67.55	72.14	76.8
Ala panchayath	65.38	65.48	76.36	71.22
Mean ± SE	65.34±2.614	65.824±2.27	73.522±2.407	73.572±2.772

The two way ANOVA result revealed that there is no significant variation in the sand content of various sites (F=0.2478, P>0.05) and significant variation in the content between seasons (F=13.47598, P<0.05) (Table 1.5.12).

Table 1.5.12 : Two way ANOVA showing Sand content of the soil at different study sites during post monsoon and summer season (Before flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	7.79167	4	1.947918	0.2478	0.905495	3.259167
Between Samples	317.798	3	105.9327	13.47598	0.000378	3.490295
Error	94.33021	12	7.860851			
Total	419.9199	19				

SILT (%)

The value of silt content percentage was 18.59 during November month, 18.12 in December, 23.47 in January and 22.49 during February month. (Table 1.5.13).

Table 1.5.13: Silt content of the soil at different study sites during post monsoon and summer season (Before flood)

SILT	Post monsoon		Summer	
	November	December	January	February
Chengannur	18.36	16.55	23.6	23.54
Pandanad	17.56	18.26	20.36	21.23
Thiruvanvandoor	19.25	19.75	24.68	23.15
Venmony	19.56	17.45	23.64	24.25
Ala panchayath	18.25	18.6	25.1	20.3
Mean ± SE	18.596±0.807	18.122±1.206	23.476±1.861	22.494±1.659

The two way ANOVA result revealed that there is no significant variation in the silt content of various sites ($F=1.833611$, $P>0.05$) and significant variation in the content between seasons ($F=21.29369$, $P<0.05$) (Table 1.5.14).

Table 1.5.14 : Two way ANOVA showing Silt content of the soil at different study sites during post monsoon and summer season (Before flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	12.62632	4	3.15658	1.833611	0.187263	3.259167
Between Samples	109.9719	3	36.65729	21.29369	4.26E-05	3.490295
Error	20.65812	12	1.72151			
Total	143.2563	19				

CLAY (%)

The clay percentage was high in post monsoon season followed by summer season. (Table 1.5.15). The two way ANOVA result revealed that there is no significant variation in the clay content of various sites ($F=2.863987$, $P>0.05$) and significant variation in the content between seasons ($F=21.81667$, $P<0.05$) (Table 1.5.16).

Table 1.5.15: Clay content of the soil at different study sites during post monsoon and summer season (Before flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Chengannur	8.56	8.16	6.56	6.85
Pandanad	8.25	7.48	7.12	6.95
Thiruvanvandoor	8	7.12	6.86	6.4
Venmony	7.45	7.3	6.32	6.55
Ala panchayath	8.36	8.42	7.11	6.34
Mean ± SE	8.124±0.427	7.696±0.564	6.794±0.349	6.618±0.271

Table 1.5.16 : Two way ANOVA showing Clay content of the soil at different study sites during post monsoon and summer season (Before flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	1.36237	4	0.340593	2.863987	0.070471	3.259167
Between Samples	7.78348	3	2.594493	21.81667	3.78E-05	3.490295
Error	1.42707	12	0.118923			
Total	10.57292	19				

NITROGEN (ppm)

The Nitrogen content was 2546.3 ppm during November month, 2549.2ppm in December, 2625.7ppm in January and 2632.2ppm during February month. (Table 1.5.17). Two way ANOVA result showed that there is no significant difference in the Nitrogen content between sites ($F=0.349567$, $P>0.05$) and there is difference between seasons ($F=17.60312$, $P<0.05$) (Table 1.5.18)

Table 1.5.17: Nitrogen content of the soil at different study sites during post monsoon and summer season (Before flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Chengannur	2580.36	2543.6	2618.45	2624.56
Pandanad	2586.34	2534.16	2623.58	2647.15
Thiruvanvandoor	2515.36	2574	2605.59	2634.15
Venmony	2513.52	2561.2	2638.15	2605.45
Ala panchayath	2536	2533.1	2642.9	2649.7
Mean ± SE	2546.316±35.004	2549.212±17.859	2625.734±15.102	2632.202±18.079

Table 1.5.18 : Two way ANOVA showing Nitrogen content of the soil at different study sites during post monsoon and summer season (Before flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	876.3049	4	219.0762	0.349567	0.839386	3.259167
Between Samples	33096	3	11032	17.60312	0.000108	3.490295
Error	7520.485	12	626.7071			
Total	41492.79	19				

PHOSPHORUS (ppm)

The Phosphorus content almost same with value ranging from an average of 7.5ppm in to 8.3ppm during summer and post monsoon seasons (Table 1.5.19). Two way ANOVA result showed that there is no significant difference in the Phosphorus content between sites ($F=0.557152$, $P>0.05$) and there is difference between seasons ($F=16.4667$, $P<0.05$) (Table 1.5.20)

Table 1.5.19: Phosphorus content of the soil at different study sites during post monsoon and summer season (Before flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Chengannur	8.56	8.45	7.42	7.7
Pandanad	8.12	8.13	7.53	7.52
Thiruvanvandoor	8.36	8.25	7.65	7.36
Venmony	8.47	7.95	7.84	7.84
Ala panchayath	8.26	8.68	7.12	7.42
Mean ± SE	8.354±0.172	8.292±0.283	7.512±0.268	7.568±0.199

Table 1.5.20 : Two way ANOVA showing Phosphorus content of the soil at different study sites during post monsoon and summer season (Before flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.13908	4	0.03477	0.557152	0.698013	3.259167
Between Samples	3.082895	3	1.027632	16.4667	0.000149	3.490295
Error	0.74888	12	0.062407			
Total	3.970855	19				

POTASSIUM (ppm)

The Potassium content was high in Post monsoon (155ppm) followed by summer (143ppm) (Table 1.5.21).There is no significant difference in the Potassium content between sites ($F=1.675882$, $P>0.05$) and there is difference between seasons ($F=16.79612$, $P<0.05$) (Table 1.5.22)

Table 1.5.21: Potassium content of the soil at different study sites during post monsoon and summer season (Before flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Chengannur	155.23	153.64	134.56	138.45
Pandanad	148.25	150.8	138.16	146.25
Thiruvanvandoor	153.68	159.6	142.33	148.4
Venmony	158.15	154.8	146.25	139.7
Ala panchayath	146.38	156.55	139.1	142.33
Mean ± SE	152.338±4.902	155.078±3.281	140.08±4.422	143.026±4.235

Table 1.5.22 : Two way ANOVA showing Potassium content of the soil at different study sites during post monsoon and summer season (Before flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	103.6608	4	25.91521	1.675882	0.219746	3.259167
Between Samples	779.1864	3	259.7288	16.79612	0.000136	3.490295
Error	185.5635	12	15.46362			
Total	1068.411	19				

CALCIUM (ppm)

The Calcium content was an average of 691 ppm in post monsoon and 633ppm during summer season (Table 1.5.23). There is no significant difference in Calcium content between sites ($F=1.454599$, $P>0.05$) and between seasons there is variation ($F=222.0027$, $P<0.05$) (Table 1.5.24).

Table 1.5.23: Calcium content of the soil at different study sites during post monsoon and summer season (Before flood)

	Post monsoon		Summer	
Sites	November	December	January	February
Chengannur	682.36	696.34	628.26	643.15
Pandanad	676.25	687.16	629.45	640.2
Thiruvanvandoor	680.3	693.22	631.45	638.49
Venmony	679.8	697.21	638.15	643.54
Ala panchayath	685.91	684.3	640.2	645.6
Mean ± SE	680.924±3.55	691.646±5.691	633.502±5.351	642.196±2.829

Table 1.5.24 : Two way ANOVA showing Calcium content of the soil at different study sites during post monsoon and summer season (Before flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	106.6396	4	26.65989	1.454599	0.276093	3.259167
Between Samples	12206.6	3	4068.866	222.0027	8.95E-11	3.490295
Error	219.9361	12	18.32801			
Total	12533.17	19				

MAGNESIUM (ppm)

The Magnesium content was an average of 146ppm in post monsoon to 126 ppm in summer (Table 1.5.25). There is no significant difference in Magnesium content between sites ($F=1.80917$, $P>0.05$) and between seasons there is variation ($F=27.0728$, $P<0.05$) (Table 1.5.26).

Table 1.5.25: Magnesium content of the soil at different study sites during post monsoon and summer season (Before flood)

	Post monsoon		Summer	
Sites	November	December	January	February
Chengannur	142.3	152.3	132.25	126.45
Pandanad	140.26	146.78	128.66	120.3
Thiruvanvandoor	148.25	143.4	133.54	127.48
Venmony	150.23	140.26	138.25	123.4
Ala panchayath	147.66	148.69	136.45	134.68
Mean ± SE	145.74±4.242	146.286±4.659	133.83±3.731	126.462±5.383

Table 1.5.26 : Two way ANOVA showing Magnesium content of the soil at different study sites during post monsoon and summer season (before flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	124.3208	4	31.08021	1.80917	0.191931	3.259167
Between Samples	1395.272	3	465.0908	27.0728	1.26E-05	3.490295
Error	206.1512	12	17.17927			
Total	1725.744	19				

MOISTURE (%)

The moisture content also varied from an average of 70% in summer to 76% in post monsoon. (Table 1.5.27). There is no significant difference in Moisture content between sites ($F=1.436975$, $P>0.05$) and between seasons there is variation ($F=45.4958$, $P<0.05$) (Table 1.5.28).

Table 1.5.27: Moisture content of the soil at different study sites during post monsoon and summer season (Before flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Chengannur	78	75	70	70
Pandanad	76	75	72	72
Thiruvanvandoor	77	76	70	72
Venmony	75	75	70	70
Ala panchayath	78	76	70	72
Mean ± SE	76.8±1.3	75.4±0.54	70.8±1.41	71.2±1.09

Table 1.5.28 : Two way ANOVA showing moisture content of the soil at different study sites during post monsoon and summer season (Before flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	5.7	4	1.425	1.436975	0.281205	3.259167
Between Samples	135.35	3	45.11667	45.4958	7.88E-07	3.490295
Error	11.9	12	0.991667			
Total	152.95	19				

Fig.5.1: Mean soil edaphic factors of the study area (Chengannur) during post monsoon season
(Before flood and after flood)

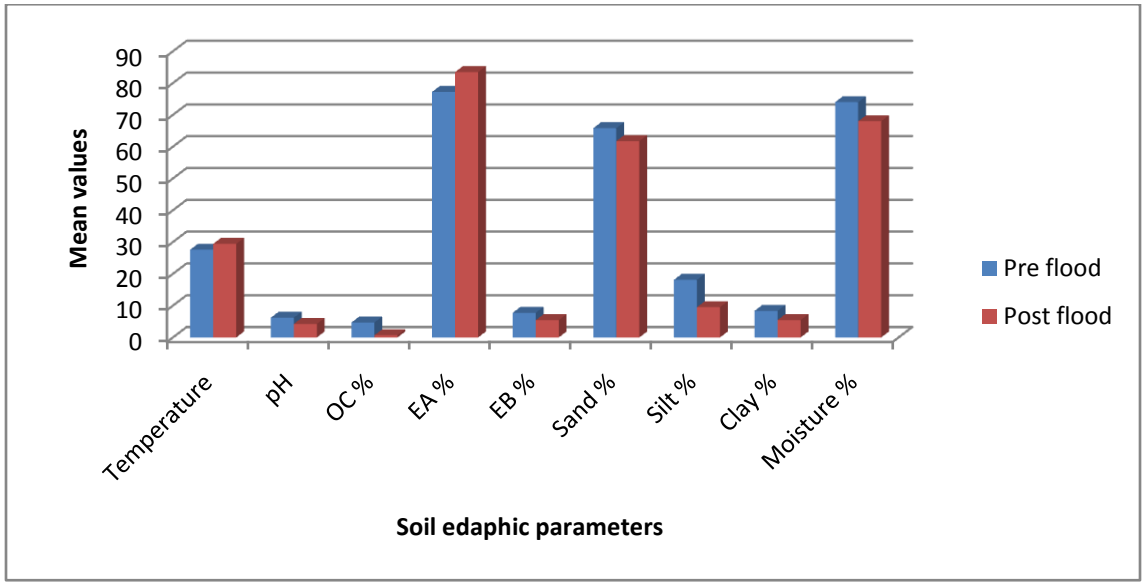
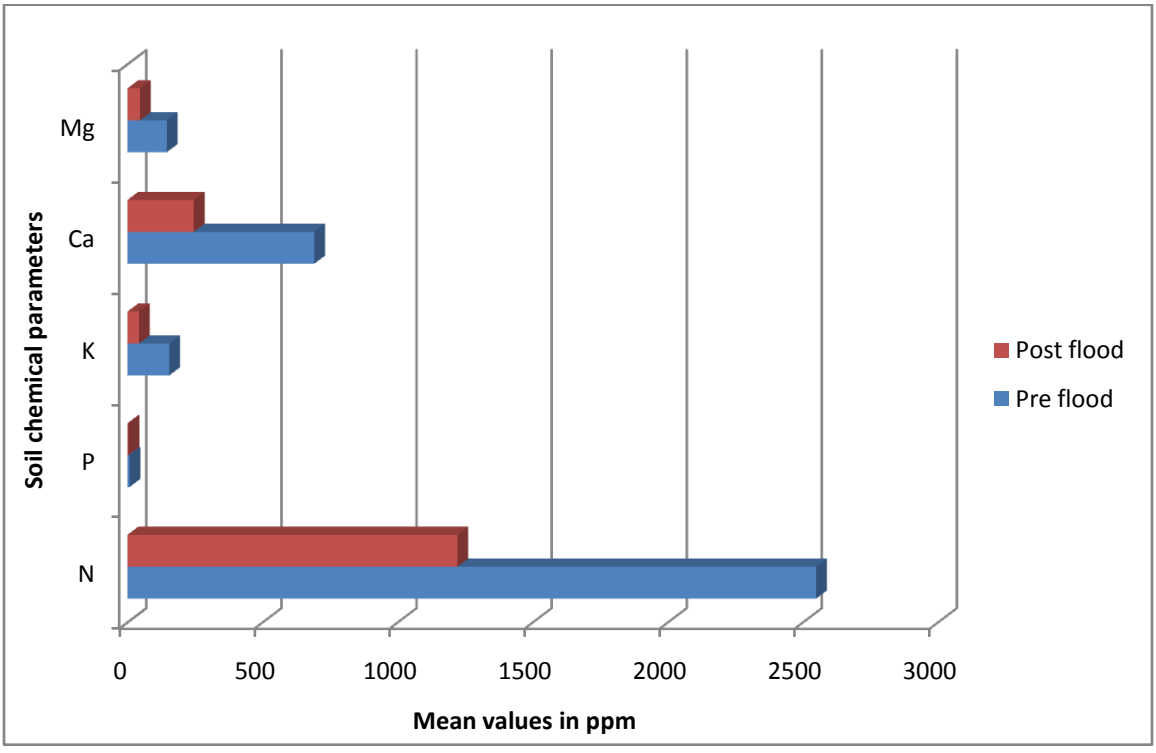


Fig.5.2: Mean soil chemical factors of the study area (Chengannur) during post monsoon season
(Before flood and after flood)



POST FLOOD

1.6.1 Soil edaphic and chemical properties in Chengannur area after flood

TEMPERATURE (^{0}C)

The mean soil temperature during November month was 29.4˚C, 29.4 ˚C in December. 30.9˚C in January and 30.8˚C in February (Table 1.6.1). There is significant variation in soil temperature between months (F=15.9576, P<0.05) and no difference between sites (F=1.359011,, P>0.05) (Table 1.6.2).

Table 1.6.1: Temperature of the soil at different study sites during post monsoon and summer season (After flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Chengannur	29	29.1	30.8	30.2
Pandanad	29.6	29.4	31.6	31.2
Thiruvanvandoor	29.4	29.6	31.9	30.4
Venmony	29.5	29.4	30.2	30.8
Ala panchayath	29.5	29.7	30.4	31.7
Mean ± SE	29.4±0.234	29.44±0.230	30.98±0.742	30.86±0.606

Table 1.2 : Two way ANOVA showing Temperature of the soil at different study sites during post monsoon and summer season (After flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	1.282	4	0.3205	1.359011	0.305054	3.259167
Between Samples	11.29	3	3.763333	15.9576	0.000173	3.490295
Error	2.83	12	0.235833			
Total	15.402	19				

pH

The pH value was high in post monsoon season (4.6) followed by summer season (3.6) (Table 1.6.3). There was significant difference in the pH between seasons, P<0.05 (Table 1.6.4)

Table 1.6.3: pH of the soil at different study sites during post monsoon and summer season (After flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Chengannur	4.56	4.44	3.85	3.6
Pandanad	4.68	4.26	3.56	3.48
Thiruvanvandoor	4.69	4.58	3.98	3.98
Venmony	4.85	4.68	3.64	3.5
Ala panchayath	4.26	4.56	3.45	3.45
Mean ± SE	4.608±0.220	4.504±0.160	3.696±0.215	3.602±0.218

Table 1.6.4 : Two way ANOVA showing pH of the soil at different study sites during post monsoon and summer season (After flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.35065	4	0.087663	3.241257	0.050765	3.259167
Between Samples	4.162375	3	1.387458	51.30026	4.07E-07	3.490295
Error	0.32455	12	0.027046			
Total	4.837575	19				

ORGANIC CARBON (%)

The value of organic carbon percentage was 0.75 during post monsoon and 0.76 during summer season. (Table 1.6.5). There is no significant difference in the pH between sites and also seasons (P>0.05) (Table 1.6.6)

Table 1.6.5: Organic carbon content of the soil at different study sites during post monsoon and summer season (After flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Chengannur	0.7	0.78	0.77	0.74
Pandanad	0.78	0.76	0.7	0.75
Thiruvanvandoor	0.74	0.74	0.8	0.76
Venmony	0.7	0.74	0.83	0.77
Ala panchayath	0.76	0.73	0.72	0.78
Mean ± SE	0.736±0.035	0.75±0.02	0.764±0.054	0.76±0.015

Table 1.6.6 : Two way ANOVA showing Organic carbon content of the soil at different study sites during post monsoon and summer season (After flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.00075	4	0.000188	0.120385	0.972537	3.259167
Between Samples	0.002335	3	0.000778	0.499732	0.689441	3.490295
Error	0.01869	12	0.001558			
Total	0.021775	19				

EA AND EB (%)

Exchangeable acid value varied from an average of 80.86% in post monsoon to 84.3% in summer. Exchangeable Base value varied from an average of 4.3% in summer to 5.5% in post monsoon (Table 1.6.7 and 1.6.9).

Table 1.6.7: EA of the soil at different study sites during post monsoon and summer season (After flood)

EA	Post monsoon		Summer	
	November	December	January	February
Chengannur	82.36	84.12	89.36	87.45
Pandanad	81.32	83.65	90.12	86.12
Thiruvanvandoor	79.26	84.15	85.25	88.9
Venmony	80.15	80.23	84	89.13
Ala panchayath	81.22	85.16	85.6	90.12
Mean ± SE	80.862±1.189	83.462±1.881	86.866±2.703	88.344±1.567

Table 1.6.8 : Two way ANOVA showing EA of the soil at different study sites during post monsoon and summer season (After flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	15.92153	4	3.980383	1.109059	0.396717	3.259167
Between Samples	170.4925	3	56.83082	15.83484	0.000179	3.490295
Error	43.06767	12	3.588973			
Total	229.4817	19				

Table 1.6.9: EB of the soil at different study sites during post monsoon and summer season (After flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Chengannur	5.12	5.22	4.12	4.56
Pandanad	5.16	5.85	4.36	4.87
Thiruvanvandoor	5.48	5.47	4.55	4.31
Venmony	5.98	5.63	4.85	4.3
Ala panchayath	5.45	5.48	4.1	4.08
Mean ± SE	5.438±0.344	5.53±0.231	4.396±0.314	4.424±0.301

In both case, there was no difference in values between sites (P>0.05) and there is difference between seasons (P<0.05) (Table 1.6.8 and 1.6.10).

Table 1.6.10 : Two way ANOVA showing EB of the soil at different study sites during post monsoon and summer season (After flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.54977	4	0.137443	1.83675	0.186672	3.259167
Between Samples	5.7905	3	1.930167	25.79431	1.62E-05	3.490295
Error	0.89795	12	0.074829			
Total	7.23822	19				

SAND (%)

The sand percentage with an average of 62.1% in post monsoon followed by 73.4% during summer (Table 1.6.11). The two way ANOVA result revealed that there is no significant variation in the sand content of various sites (F=1.181075, P>0.05) and significant variation in the content between seasons (F=31.34373, P<0.05) (Table 1.6.12).

Table 1.6.11: Sand content of the soil at different study sites during post monsoon and summer season (After flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Chengannur	59.46	62.15	68.46	72.3
Pandanad	60.12	63.45	69.32	74.51
Thiruvanvandoor	62.56	60.2	70.16	76.34
Venmony	63.45	64.52	70.77	75.65
Ala panchayath	65.25	58.46	70.25	68.59
Mean ± SE	62.168±2.388	61.756±2.446	69.792±0.908	73.478±3.132

Table 1.6.12 : Two way ANOVA showing Sand content of the soil at different study sites during post monsoon and summer season (After flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	25.23273	4	6.308183	1.181075	0.36774	3.259167
Between Samples	502.2255	3	167.4085	31.34373	5.86E-06	3.490295
Error	64.09263	12	5.341052			
Total	591.5509	19				

SILT (%)

The value of silt content percentage was 9.46 during November month, 9.51 in December, 7.2 in January and 7.15 during February month. (Table 1.6.13).

Table 1.6.13: Silt content of the soil at different study sites during post monsoon and summer season (After flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Chengannur	9.65	9.45	7.12	6.98
Pandanad	9.36	9.25	7.52	7.02
Thiruvanvandoor	9.78	9.78	7.15	6.85
Venmony	9.52	9.77	6.39	7.36
Ala panchayath	9.02	9.3	7.85	7.54
Mean ± SE	9.466±0.293	9.51±0.252	7.206±0.545	7.15±0.288

The two way ANOVA result revealed that there is no significant variation in the silt content of various sites (F=0.121551, P>0.05) and significant variation in the content between seasons (F=52.33008, P<0.05) (Table 1.6.14).

Table 1.6.14 : Two way ANOVA showing Silt content of the soil at different study sites during post monsoon and summer season (After flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.08267	4	0.020667	0.121551	0.972057	3.259167
Between Samples	26.69318	3	8.897727	52.33008	3.64E-07	3.490295
Error	2.04037	12	0.170031			
Total	28.81622	19				

CLAY (%)

The clay percentage was high in post monsoon season followed by summer season. (Table 1.6.15). The two way ANOVA result revealed that there is no significant variation in the clay content of various sites (F=0.316649, P>0.05) and significant variation in the content between seasons (F=14.13502, P<0.05) (Table 1.6.16).

Table 1.6.15: Clay content of the soil at different study sites during post monsoon and summer season (After flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Chengannur	5.12	5.55	4.16	4.75
Pandanad	5.36	5.16	4.58	4.56
Thiruvanvandoor	5.98	5.48	4.36	4.12
Venmony	5.48	5.47	4.58	4.85
Ala panchayath	5.23	5.69	4.99	4.36
Mean ± SE	5.434±0.333	5.47±0.194	4.534±0.309	4.528±0.295

Table 1.2 : Two way ANOVA showing Clay content of the soil at different study sites during post monsoon and summer season (After flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.12678	4	0.031695	0.316649	0.861417	3.259167
Between Samples	4.244535	3	1.414845	14.13502	0.000304	3.490295
Error	1.20114	12	0.100095			
Total	5.572455	19				

NITROGEN (ppm)

The Nitrogen content was 1221.6ppm during November month, 1230.56ppm in December, 1184.7ppm in January and 1190.24ppm during February month. (Table 1.6.17). Two way ANOVA result showed that there is no significant difference in the Nitrogen content between sites ($F=0.728844$, $P>0.05$) and there is difference between seasons ($F=21.51902$, $P<0.05$) (Table 1.6.18)

Table 1.6.17: Nitrogen content of the soil at different study sites during post monsoon and summer season (After flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Chengannur	1216.25	1236.12	1185.16	1192.45
Pandanad	1236.25	1223.11	1176.26	1191.8
Thiruvanvandoor	1236.15	1246.46	1186.59	1187.15
Venmony	1210.1	1237.12	1180.4	1186.15
Ala panchayath	1209.45	1210	1195.12	1193.67
Mean ± SE	1221.64±13.553	1230.562±14.186	1184.706±7.107	1190.244±3.367

Table 1.6.18 : Two way ANOVA showing Nitrogen content of the soil at different study sites during post monsoon and summer season (After flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	349.3336	4	87.33339	0.728844	0.589244	3.259167
Between Samples	7735.518	3	2578.506	21.51902	4.05E-05	3.490295
Error	1437.894	12	119.8245			
Total	9522.746	19				

PHOSPHORUS (ppm)

The Phosphorus content almost same with value ranging from an average of 4.22ppm to 4.73ppm during post monsoon and summer seasons (Table 1.6.19). Two way ANOVA result showed that there is no significant difference in the Phosphorus content between sites (F=0.686676, P>0.05) and there is difference between seasons (F=6.354435, P<0.05) (Table 1.6.18)

Table 1.6.19: Phosphorus content of the soil at different study sites during post monsoon and summer season (After flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Chengannur	4.22	4.13	4.56	4.63
Pandanad	4.25	4.28	4.85	4.87
Thiruvanvandoor	4.15	4.15	4.68	4.56
Venmony	4.23	4.85	4.59	4.35
Ala panchayath	4.25	4.36	4.99	4.56
Mean ± SE	4.22±0.014	4.354±0.292	4.734±0.182	4.594±0.186

Table 1.6.20 : Two way ANOVA showing Phosphorus content of the soil at different study sites during post monsoon and summer season (After flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.11592	4	0.02898	0.686676	0.614826	3.259167
Between Samples	0.804535	3	0.268178	6.354435	0.007966	3.490295
Error	0.50644	12	0.042203			
Total	1.426895	19				

POTASSIUM (ppm)

The Potassium content was high in Post monsoon (44.33ppm) followed by summer (35.81ppm) (Table 1.6.21).There is no significant difference in the Potassium content between sites (F=1.128796, P>0.05) and there is difference between seasons (F=16.37652, P<0.05) (Table 1.6.22)

Table 1.6.21: Potassium content of the soil at different study sites during post monsoon and summer season (After flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Chengannur	40.25	44.68	35.12	33.25
Pandanad	43.25	43.65	32.26	31.26
Thiruvanvandoor	45.86	45.78	31.36	36.56
Venmony	41.23	46.35	38.45	38.45
Ala panchayath	43.3	41.2	36.44	39.54
Mean ± SE	42.778±2.166	44.332±2.034	34.726±2.931	35.812±3.489

Table 1.6.22 : Two way ANOVA showing Potassium content of the soil at different study sites during post monsoon and summer season (After flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	32.37532	4	8.09383	1.128796	0.388555	3.259167
Between Samples	352.2748	3	117.4249	16.37652	0.000153	3.490295
Error	86.04384	12	7.17032			
Total	470.6939	19				

CALCIUM (ppm)

The Calcium content was an average of 249ppm in post monsoon and 237ppm during summer season. (Table 1.6.23). There is no significant difference in Calcium content between sites ($F=1.176689$, $P>0.05$) and between seasons there is variation ($F=13.40205$, $P<0.05$) (Table 1.6.24).

Table 1.6.23: Calcium content of the soil at different study sites during post monsoon and summer season (After flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Chengannur	250.12	246.52	238.66	241.45
Pandanad	245.36	248.22	229.36	236.68
Thiruvanvandoor	240.11	249.56	230.18	237.43
Venmony	243.36	251.3	240.45	239.6
Ala panchayath	251.23	254.26	238.6	230.15
Mean ± SE	246.036±4.647	249.972±2.970	235.45±5.246	237.062±4.293

Table 1.6.24 : Two way ANOVA showing Calcium content of the soil at different study sites during post monsoon and summer season (After flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	86.07875	4	21.51969	1.176689	0.369442	3.259167
Between Samples	735.3041	3	245.1014	13.40205	0.000388	3.490295
Error	219.4601	12	18.28834			
Total	1040.843	19				

MAGNESIUM (ppm)

The Magnesium content was an average of 48.05ppm in post monsoon to 36.43ppm in summer (Table 1.6.25). There is no significant difference in Magnesium content between sites and also between seasons, P>0.05 (Table 1.6.26).

Table 1.6.25: Magnesium content of the soil at different study sites during post monsoon and summer season (After flood)

Sites	Post monsoon		Summer	
	November	December	January	February
Chengannur	46.22	45.23	34.56	35.47
Pandanad	46.39	48.26	32.16	33.1
Thiruvanvandoor	48.23	45.7	39.35	38.45
Venmony	49.2	46.22	35.64	36.74
Ala panchayath	50.23	47.85	37.1	38.4
Mean ± SE	48.054±1.747	46.652±1.335	35.762±2.697	36.432±2.239

Table 1.6.26 : Two way ANOVA showing Magnesium content of the soil at different study sites during post monsoon and summer season (After flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	36.74945	4	9.187362	3.470846	0.041889	3.259167
Between Samples	639.5239	3	213.1746	80.53416	3.22E-08	3.490295
Error	31.76411	12	2.647009			
Total	708.0375	19				

MOISTURE (%)

The moisture content also varied from an average of 59% in summer to 67% in post monsoon. (Table 1.6.27). There is no significant difference in Moisture content between sites ($F=1.239521$, $P>0.05$) and between seasons there is variation ($F=22.46707$, $P<0.05$) (Table 1.6.28).

Table 1.6.27: Moisture content of the soil at different study sites during post monsoon and summer season (Before flood)

	Post monsoon		Summer	
Sites	November	December	January	February
Chengannur	68	66	64	61
Pandanad	66	68	62	59
Thiruvanvandoor	65	67	61	56
Venmony	69	64	60	60
Ala panchayath	67	65	63	61
Mean ± SE	67±1.28	66±1.59	62±1.57	59.4±2.07

Table 1.5.28 : Two way ANOVA showing moisture content of the soil at different study sites during post monsoon and summer season (After flood)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	13.8	4	3.45	1.239521	0.345803	3.259167
Between Samples	187.6	3	62.53333	22.46707	3.26E-05	3.490295
Error	33.4	12	2.783333			
Total	234.8	19				

Fig.6.1: Mean soil edaphic factors of the study area (Chengannur) during summer season (Before flood and after flood)

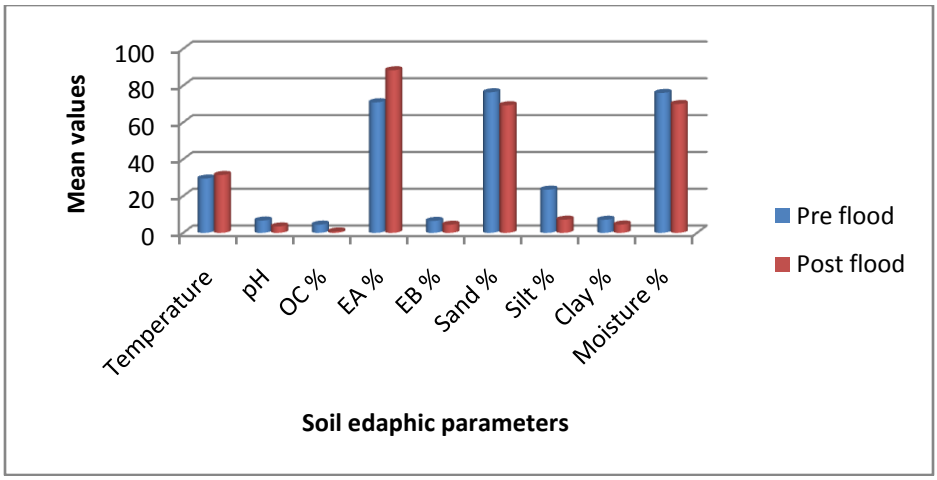
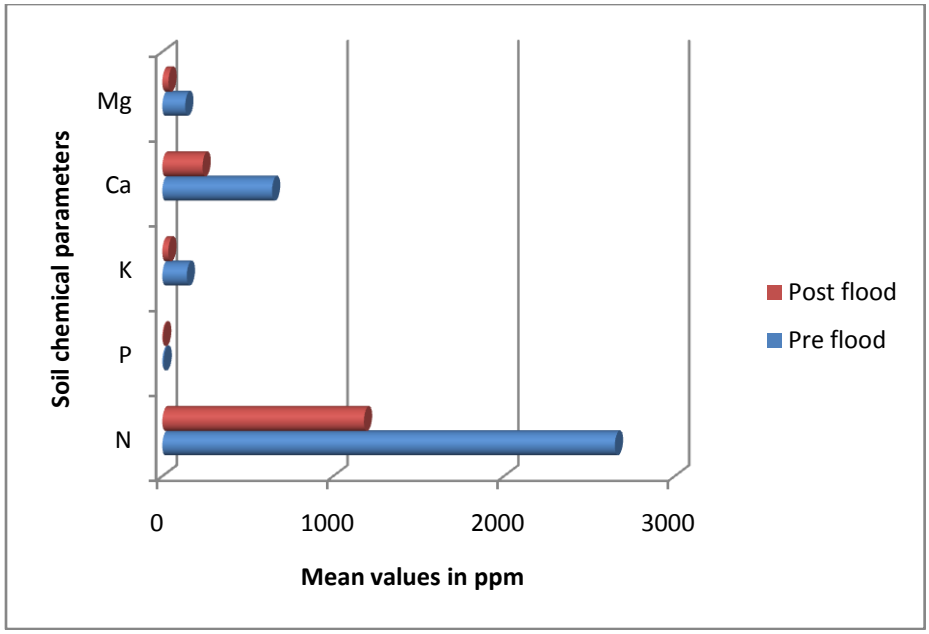


Fig.6.1: Mean soil chemical factors of the study area (Chengannur) during summer season (Before flood and after flood)



Pre- flood with Post-flood soil physico-chemical parameters comparison

RANNI AREA

2.1 Soil physico-chemical parameters comparison between Pre- flood and Post-flood conditions during Post monsoon and summer Season

Temperature:

Table 2.1.1 : Two way ANOVA showing Temperature of the soil at Pre- flood and Post-flood conditions during Post monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	2.385	4	0.59625	3.139535	0.055375	3.259167
Between Samples	17.366	3	5.788667	30.48004	6.78E-06	3.490295
Error	2.279	12	0.189917			
Total	22.03	19				

Two way ANOVA result showed that there is significant difference in the temperature between pre flood and post flood during post monsoon season ($F=30.48004$, $P<0.05$) (Table 2.1.1)

Table 2.1.2 : Two way ANOVA showing Temperature of the soil at Pre- flood and Post-flood conditions during Summer monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.607	4	0.15175	0.389019	0.812537	3.259167
Between Samples	1.954	3	0.651333	2.669729	0.036092	1.490295
Error	4.681	12	0.390083			
Total	7.242	19				

Two way ANOVA result showed that there is significant difference in the temperature between pre flood and post flood during summer season ($F=2.669729$, $P<0.05$) (Table 2.1.2)

pH

Table 2.1.3 : Two way ANOVA showing p ^{H} of the soil at Pre- flood and Post-flood conditions during Post monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.02437	4	0.006092	0.174858	0.947069	3.259167
Between Samples	23.07604	3	7.692013	220.7653	9.24E-11	3.490295
Error	0.41811	12	0.034843			
Total	23.51852	19				

Two way ANOVA result showed that there is significant difference in the pH between pre flood and post flood during post monsoon season (F=220.7653, P<0.05) (Table 2.1.3)

Table 2.1.4 : Two way ANOVA showing pH of the soil at Pre- flood and Post-flood conditions during Summer monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.25183	4	0.062958	1.104308	0.398707	3.259167
Between Samples	3.955695	3	1.318565	23.12832	2.82E-05	3.490295
Error	0.68413	12	0.057011			
Total	4.891655	19				

Two way ANOVA result showed that there is significant difference in the pH between pre flood and post flood during summer season (F=23.12832, P<0.05) (Table 2.1.4)

ORGANIC CARBON

Table 2.1.5 : Two way ANOVA showing Organic carbon of the soil at Pre- flood and Post-flood conditions during Post monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.08185	4	0.020462	0.888419	0.500031	3.259167
Between Samples	39.67794	3	13.22598	574.2311	3.2E-13	3.490295
Error	0.27639	12	0.023033			
Total	40.03618	19				

Two way ANOVA result showed that there is significant difference in the OC between pre flood and post flood during post monsoon season (F=574.2311, P<0.05) (Table 2.1.5)

Table 2.1.6 : Two way ANOVA showing OC of the soil at Pre- flood and Post-flood conditions during Summer monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.16232	4	0.04058	0.669416	0.625524	3.259167
Between Samples	65.34774	3	21.78258	359.3299	5.2E-12	3.490295
Error	0.72744	12	0.06062			
Total	66.2375	19				

Two way ANOVA result showed that there is significant difference in the OC between pre flood and post flood during summer season (F=359.3299, P<0.05) (Table 2.1.6)

EXCHANGEABLE ACID

Table 2.1.7 : Two way ANOVA showing EA of the soil at Pre- flood and Post-flood conditions during Post monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	13.13357	4	3.283392	1.56578	0.246049	3.259167
Between Samples	106.288	3	35.42934	16.8955	0.000132	3.490295
Error	25.16363	12	2.096969			
Total	144.5852	19				

Two way ANOVA result showed that there is significant difference in the EA between pre flood and post flood during post monsoon season (F=16.8955, P<0.05) (Table 2.1.7).

Table 2.1.8 : Two way ANOVA showing EA of the soil at Pre- flood and Post-flood conditions during Summer monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	29.36967	4	7.342417	1.039049	0.427057	3.259167
Between Samples	172.805	3	57.60167	8.151398	0.00316	3.490295
Error	84.79773	12	7.066478			
Total	286.9724	19				

Two way ANOVA result showed that there is significant difference in the EA between pre flood and post flood during summer season ($F=8.151398$, $P<0.05$) (Table 2.1.8)

EXCHANGEABLE BASE

Table 2.1.9 : Two way ANOVA showing EB of the soil at Pre- flood and Post-flood conditions during Post monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.11107	4	0.027768	0.216217	0.924326	3.259167
Between Samples	5.013135	3	1.671045	13.01192	0.000443	3.490295
Error	1.54109	12	0.128424			
Total	6.665295	19				

Two way ANOVA result showed that there is significant difference in the EB between pre flood and post flood during Post monsoon season ($F=13.01192$, $P<0.05$) (Table 2.1.9).

Table 2.1.10 : Two way ANOVA showing EB of the soil at Pre- flood and Post-flood conditions during Summer monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.03892	4	0.00973	0.148225	0.960258	3.259167
Between Samples	5.67018	3	1.89006	28.79287	9.14E-06	3.490295
Error	0.78772	12	0.065643			
Total	6.49682	19				

Two way ANOVA result showed that there is significant difference in the EB between pre flood and post flood during Post monsoon season (F=28.79287, P<0.05) (Table 2.1.10)

SAND

Table 2.1.11: Two way ANOVA showing Sand content of the soil at Pre- flood and Post-flood conditions during Post monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	3.46072	4	0.86518	0.142734	0.96281	3.259167
Between Samples	20.64722	3	6.882407	13.01192	0.000443	3.490295
Error	72.73768	12	6.061473			
Total	96.84562	19				

Two way ANOVA result showed that there is significant difference in the sand content between pre flood and post flood during Post monsoon season (F=13.01192, P<0.05) (Table 2.1.11)

Table 2.1.12 : Two way ANOVA showing Sand content of the soil at Pre- flood and Post-flood conditions during Summer monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	46.0572	4	11.5143	2.84402	0.071736	3.259167
Between Samples	5.430775	3	1.810258	0.447132	0.723837	3.490295
Error	48.5832	12	4.0486			
Total	100.0712	19				

Two way ANOVA result showed that there is significant difference in the sand content between pre flood and post flood during Summer season (F=0.447132, P<0.05) (Table 2.1.12).

Table 2.1.13 : Two way ANOVA showing silt content of the soil at Pre- flood and Post-flood conditions during Post monsoon

SILT

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	14.9479	4	3.736975	2.430698	0.104735	3.259167
Between Samples	291.457	3	97.15233	63.19228	1.27E-07	3.490295
Error	18.4489	12	1.537408			
Total	324.8538	19				

Two way ANOVA result showed that there is significant difference in the silt content between pre flood and post flood during post monsoon season ($F=63.19228$, $P<0.05$) (Table 2.1.13)

Table 2.1.14 : Two way ANOVA showing Silt content of the soil at Pre- flood and Post-flood conditions during Summer monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	22.28405	4	5.571013	0.666467	0.627365	3.259167
Between Samples	235.9586	3	78.65287	9.409342	0.001782	3.490295
Error	100.3082	12	8.359019			
Total	358.5509	19				

Two way ANOVA result showed that there is significant difference in the silt content between pre flood and post flood during Summer season ($F=9.409342$, $P<0.05$) (Table 2.1.14)

CLAY

Table 2.1.15 : Two way ANOVA showing Clay content of the soil at Pre- flood and Post-flood conditions during Post monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	14.9479	4	3.736975	2.430698	0.104735	3.259167
Between Samples	291.457	3	97.15233	63.19228	1.27E-07	3.490295
Error	18.4489	12	1.537408			
Total	324.8538	19				

Two way ANOVA result showed that there is significant difference in the clay content between pre flood and post flood during post monsoon season ($F=63.19228$, $P<0.05$) (Table 2.1.15)

Table 2.1.16 : Two way ANOVA showing clay content of the soil at Pre- flood and Post-flood conditions during Summer monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.20488	4	0.05122	0.932856	0.47738	3.259167
Between Samples	7.303095	3	2.434365	44.33642	9.08E-07	3.490295
Error	0.65888	12	0.054907			
Total	8.166855	19				

Two way ANOVA result showed that there is significant difference in the clay content between pre flood and post flood during Summer season ($F=44.33642$, $P<0.05$) (Table 2.1.16).

NITROGEN

Table 2.1.17 : Two way ANOVA showing Nitrogen content of the soil at Pre- flood and Post-flood conditions during Post monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	6.75023	4	1.687558	0.921013	0.483323	3.259167
Between Samples	143.0595	3	47.68651	26.02572	1.54E-05	3.490295
Error	21.98741	12	1.832284			
Total	171.7972	19				

Two way ANOVA result showed that there is significant difference in the nitrogen content between pre flood and post flood during Post monsoon season ($F=26.02572$, $P<0.05$) (Table 2.1.17)

Table 2.1.18 : Two way ANOVA showing Nitrogen content of the soil at Pre- flood and Post-flood conditions during Summer monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	97.95118	4	24.4878	0.834941	0.52856	3.259167
Between Samples	7767722	3	2589241	88283.3	2.54E-26	3.490295
Error	351.9452	12	29.32877			
Total	7768172	19				

Two way ANOVA result showed that there is significant difference in the nitrogen content between pre flood and post flood during summer season ($F=88283.3$, $P<0.05$) (Table 2.1.18)

PHOSPHORUS

Table 2.1.19 : Two way ANOVA showing Phosphorus content of the soil at Pre- flood and Post-flood conditions during Post monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.15885	4	0.039713	0.827128	0.532844	3.259167
Between Samples	123.1178	3	41.03927	854.7621	2.99E-14	3.490295
Error	0.57615	12	0.048012			
Total	123.8528	19				

Two way ANOVA result showed that there is significant difference in the phosphorus content between pre flood and post flood during Post monsoon season ($F=854.7621$, $P<0.05$) (Table 2.1.19)

Table 2.1.20 : Two way ANOVA showing Phosphorus content of the soil at Pre- flood and Post-flood conditions during Summer monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.47792	4	0.11948	1.653474	0.224841	3.259167
Between Samples	82.54108	3	27.51369	380.7597	3.69E-12	3.490295
Error	0.86712	12	0.07226			
Total	83.88612	19				

Two way ANOVA result showed that there is significant difference in the phosphorus content between pre flood and post flood during summer season ($F=380.7597$, $P<0.05$) (Table 2.1.20

POTASSIUM

Table 2.1.21 : Two way ANOVA showing Potassium content of the soil at Pre- flood and Post-flood conditions during Post monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	89.95603	4	22.48901	1.144029	0.38237	3.259167
Between Samples	26905	3	8968.333	456.2245	1.26E-12	3.490295
Error	235.8926	12	19.65772			
Total	27230.85	19				

Two way ANOVA result showed that there is significant difference in the potassium content between pre flood and post flood during post monsoon season ($F=456.2245$, $P<0.05$) (Table 2.1.21).

Table 2.1.22 : Two way ANOVA showing Potassium content of the soil at Pre- flood and Post-flood conditions during Summer monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	16.91672	4	4.22918	0.613989	0.660722	3.259167
Between Samples	21629.21	3	7209.737	1046.704	8.91E-15	3.490295
Error	82.65648	12	6.88804			
Total	21728.78	19				

Two way ANOVA result showed that there is significant difference in the potassium content between pre flood and post flood during summer season ($F=1046.704$, $P<0.05$) (Table 2.1.22)

CALCIUM

Table 2.1.23 : Two way ANOVA showing Calcium content of the soil at Pre- flood and Post-flood conditions during Post monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	78.91582	4	19.72895	0.88126	0.50377	3.259167
Between Samples	465898.5	3	155299.5	6936.97	1.07E-19	3.490295
Error	268.6467	12	22.38722			
Total	466246.1	19				

Two way ANOVA result showed that there is significant difference in the Calcium content between pre flood and post flood during post monsoon season ($F=6936.97$, $P<0.05$) (Table 2.1.23)

Table 2.1.24 : Two way ANOVA showing Calcium content of the soil at Pre- flood and Post-flood conditions during Summer monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	113.2644	4	28.31609	1.304555	0.322967	3.259167
Between Samples	395208.9	3	131736.3	6069.243	2.39E-19	3.490295
Error	260.4667	12	21.70556			
Total	395582.6	19				

Two way ANOVA result showed that there is significant difference in the Calcium content between pre flood and post flood during Summer season ($F=6069.243$, $P<0.05$) (Table 2.1.24)

MAGNESIUM

Table 2.1.25 : Two way ANOVA showing Magnesium content of the soil at Pre- flood and Post-flood conditions during Post monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	49.82332	4	12.45583	0.832751	0.529758	3.259167
Between Samples	12850.12	3	4283.373	286.3705	1.99E-11	3.490295
Error	179.4894	12	14.95745			
Total	13079.43	19				

Two way ANOVA result showed that there is significant difference in the Magnesium content between pre flood and post flood during Post monsoon season ($F=286.3705$, $P<0.05$) (Table 2.1.25)

Table 2.1.26 : Two way ANOVA showing Magnesium content of the soil at Pre- flood and Post-flood conditions during Summer monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	81.16747	4	20.29187	2.077061	0.147047	3.259167
Between Samples	36291.55	3	12097.18	1238.259	3.26E-15	3.490295
Error	117.2341	12	9.769507			
Total	36489.95	19				

Two way ANOVA result showed that there is significant difference in the Magnesium content between pre flood and post flood during Summer season ($F=1238.259$, $P<0.05$) (Table 2.1.26)

KOZHENCHERY AREA

2.2 Soil Physico-chemical parameters comparison between Pre- flood and Post-flood conditions during Post monsoon and summer Season

TEMPERATURE

Table 2.2.1 : Two way ANOVA showing Temperature of the soil at Pre- flood and Post-flood conditions during Post monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.72128	4	0.18032	0.661401	0.630536	3.259167
Between Samples	12.18978	3	4.063258	14.90375	0.000238	3.490295
Error	3.2716	12	0.272633			
Total	16.18266	19				

Two way ANOVA result showed that there is significant difference in the Temperature content between pre flood and post flood during Post monsoon season ($F=14.90375$, $P<0.05$) (Table 2.2.1)

Table 2.2.2 : Two way ANOVA showing Temperature of the soil at Pre- flood and Post-flood conditions during Summer monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.55242	4	0.138105	1.870792	0.1804	3.259167
Between Samples	1.834215	3	0.611405	8.282189	0.00297	3.490295
Error	0.88586	12	0.073822			
Total	3.272495	19				

Two way ANOVA result showed that there is significant difference in the Temperature content between pre flood and post flood during Summer season ($F=8.282189$, $P<0.05$) (Table 2.2.2)

pH

Table 2.2.3 : Two way ANOVA showing pH of the soil at Pre- flood and Post-flood conditions during Post monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.39437	4	0.098592	1.668067	0.221508	3.259167
Between Samples	7.77498	3	2.59166	43.84779	9.64E-07	3.490295
Error	0.70927	12	0.059106			
Total	8.87862	19				

Two way ANOVA result showed that there is significant difference in the pH content between pre flood and post flood during post monsoon season ($F=43.84779$, $P<0.05$) (Table 2.2.3)

Table 2.2.4 : Two way ANOVA showing pH of the soil at Pre- flood and Post-flood conditions during Summer monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.04313	4	0.010783	0.389412	0.812268	3.259167
Between Samples	13.81778	3	4.605927	166.344	4.87E-10	3.490295
Error	0.33227	12	0.027689			
Total	14.19318	19				

Two way ANOVA result showed that there is significant difference in the pH content between pre flood and post flood during Summer season ($F=166.344$, $P<0.05$) (Table 2.2.4)

ORGANIC CARBON

Table 2.2.5 : Two way ANOVA showing Organic carbon content of the soil at Pre- flood and Post-flood conditions during Post monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.07507	4	0.018767	0.692251	0.611398	3.259167
Between Samples	33.0507	3	11.0169	406.3652	2.5E-12	3.490295
Error	0.32533	12	0.027111			
Total	33.4511	19				

Two way ANOVA result showed that there is significant difference in the Organic carbon content between pre flood and post flood during post monsoon season ($F=406.3652$, $P<0.05$) (Table 2.2.5)

Table 2.2.6 : Two way ANOVA showing OC of the soil at Pre- flood and Post-flood conditions during Summer monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.02172	4	0.00543	0.241656	0.909242	3.259167
Between Samples	46.34736	3	15.44912	687.5443	1.1E-13	3.490295
Error	0.26964	12	0.02247			
Total	46.63872	19				

Two way ANOVA result showed that there is significant difference in the Organic carbon content between pre flood and post flood during Summer season ($F=687.5443$, $P<0.05$) (Table 2.2.6)

EXHANGEABLE ACID

Table 2.2.7 : Two way ANOVA showing EA of the soil at Pre- flood and Post-flood conditions during Post monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	2.52293	4	0.630733	0.419151	0.791865	3.259167
Between Samples	52.80712	3	17.60237	11.69759	0.00071	3.490295
Error	18.05743	12	1.504786			
Total	73.38748	19				

Two way ANOVA result showed that there is significant difference in the EA content between pre flood and post flood during post monsoon season ($F=11.69759$, $P<0.05$) (Table 2.2.7)

Table 2.2.8 : Two way ANOVA showing EA of the soil at Pre- flood and Post-flood conditions during Summer monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	10.52257	4	2.630643	1.58141	0.242116	3.259167
Between Samples	42.08898	3	14.02966	8.433925	0.002765	3.490295
Error	19.96175	12	1.663479			
Total	72.5733	19				

Two way ANOVA result showed that there is significant difference in the EA content between pre flood and post flood during summer season ($F=8.433925$, $P<0.05$) (Table 2.2.7)

EXCHANGEABLE BASE

Table 2.2.9 : Two way ANOVA showing EB of the soil at Pre- flood and Post-flood conditions during Post monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.25372	4	0.06343	1.75431	0.202882	3.259167
Between Samples	21.49242	3	7.16414	198.1416	1.75E-10	3.490295
Error	0.43388	12	0.036157			
Total	22.18002	19				

Two way ANOVA result showed that there is significant difference in the EB content between pre flood and post flood during post monsoon season (F=198.1416, P<0.05) (Table 2.2.9).

Table 2.2.10 : Two way ANOVA showing EB of the soil at Pre- flood and Post-flood conditions during Summer monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	1.57943	4	0.394858	5.570199	0.009015	3.259167
Between Samples	2.161	3	0.720333	10.16164	0.001296	3.490295
Error	0.85065	12	0.070888			
Total	4.59108	19				

Two way ANOVA result showed that there is significant difference in the EB content between pre flood and post flood during summer season (F=10.16164, P<0.05) (Table 2.2.10)

SAND

Table 2.2.11 : Two way ANOVA showing sand content of the soil at Pre- flood and Post-flood conditions during Post monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	6.90845	4	1.727113	0.514019	0.726976	3.259167
Between Samples	0.804535	3	0.268178	6.354435	0.007966	3.490295
Error	40.32023	12	3.360019			
Total	59.2313	19				

Two way ANOVA result showed that there is significant difference in the sand content between pre flood and post flood during post monsoon season (F=6.354435, P<0.05) (Table 2.2.11)

Table 2.2.12 : Two way ANOVA showing sand content of the soil at Pre- flood and Post-flood conditions during Summer monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	28.67148	4	7.16787	2.259582	0.123203	3.259167
Between Samples	156.1579	3	52.05263	16.40895	0.000152	3.490295
Error	38.06652	12	3.17221			
Total	222.8959	19				

Two way ANOVA result showed that there is significant difference in the sand content between pre flood and post flood during summer season ($F=16.40895$, $P<0.05$) (Table 2.2.12)

SILT

Table 2.2.13 : Two way ANOVA showing silt content of the soil at Pre- flood and Post-flood conditions during Post monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	5.1175	4	1.279375	0.679869	0.619029	3.259167
Between Samples	807.1614	3	269.0538	142.9772	1.18E-09	3.490295
Error	22.58154	12	1.881795			
Total	834.8604	19				

Two way ANOVA result showed that there is significant difference in the silt content between pre flood and post flood during post monsoon season ($F=142.9772$, $P<0.05$) (Table 2.2.13)

Table 2.2.14 : Two way ANOVA showing silt content of the soil at Pre- flood and Post-flood conditions during Summer monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	3.74283	4	0.935708	0.542738	0.707636	3.259167
Between Samples	253.9733	3	84.65778	49.10399	5.18E-07	3.490295
Error	20.68861	12	1.724051			
Total	278.4048	19				

Two way ANOVA result showed that there is significant difference in the silt content between pre flood and post flood during summer season (F=49.10399, P<0.05) (Table 2.2.14

CLAY

Table 2.2.15 : Two way ANOVA showing clay content of the soil at Pre- flood and Post-flood conditions during Post monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.31987	4	0.079968	0.347825	0.840562	3.259167
Between Samples	26.81906	3	8.939687	38.88384	1.85E-06	3.490295
Error	2.75889	12	0.229908			
Total	29.89782	19				

Two way ANOVA result showed that there is significant difference in the clay content between pre flood and post flood during post monsoon season (F=38.88384, P<0.05) (Table 2.2.15)

Table 2.2.16 : Two way ANOVA showing clay content of the soil at Pre- flood and Post-flood conditions during Summer monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.72503	4	0.181258	1.124769	0.390207	3.259167
Between Samples	2.32314	3	0.77438	4.805312	0.020119	3.490295
Error	1.93381	12	0.161151			
Total	4.98198	19				

Two way ANOVA result showed that there is significant difference in the clay content between pre flood and post flood during summer season (F=38.88384, P<0.05) (Table 2.2.15)

NITROGEN

Table 2.2.17 : Two way ANOVA showing Nitrogen content of the soil at Pre- flood and Post-flood conditions during Post monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	765.9205	4	191.4801	1.535074	0.253979	3.259167
Between Samples	9737993	3	3245998	26022.78	3.86E-23	3.490295
Error	1496.841	12	124.7368			
Total	9740256	19				

Two way ANOVA result showed that there is significant difference in the Nitrogen content between pre flood and post flood during post monsoon season ($F=26022.78$, $P<0.05$) (Table 2.2.17).

Table 2.2.18 : Two way ANOVA showing Nitrogen content of the soil at Pre- flood and Post-flood conditions during Summer monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	532.8931	4	133.2233	0.911369	0.488213	3.259167
Between Samples	10735467	3	3578489	24480.14	5.58E-23	3.490295
Error	1754.152	12	146.1793			
Total	10737755	19				

Two way ANOVA result showed that there is significant difference in the Nitrogen content between pre flood and post flood during summer season ($F=24480.14$, $P<0.05$) (Table 2.2.18).

PHOSPHORUS

Table 2.2.19 : Two way ANOVA showing Phosphorus content of the soil at Pre- flood and Post-flood conditions during Post monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.37597	4	0.093993	1.903228	0.174639	3.259167
Between Samples	40.3505	3	13.45017	272.3486	2.68E-11	3.490295
Error	0.59263	12	0.049386			
Total	41.3191	19				

Two way ANOVA result showed that there is significant difference in the Phosphorus content between pre flood and post flood during post monsoon season (F=272.3486, P<0.05) (Table 2.2.19)

Table 2.2.20 : Two way ANOVA showing Phosphorus content of the soil at Pre- flood and Post-flood conditions during Summer monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.12608	4	0.03152	0.456503	0.766208	3.259167
Between Samples	42.32614	3	14.10871	204.3359	1.46E-10	3.490295
Error	0.82856	12	0.069047			
Total	43.28078	19				

Two way ANOVA result showed that there is significant difference in the Phosphorus content between pre flood and post flood during summer season (F=204.3359, P<0.05) (Table 2.2.20)

POTASSIUM

Table 2.2.21 : Two way ANOVA showing Potassium content of the soil at Pre- flood and Post-flood conditions during Post monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	43.28012	4	10.82003	0.83032	0.531091	3.259167
Between Samples	41213.88	3	13737.96	1054.239	8.54E-15	3.490295
Error	156.3739	12	13.03116			
Total	41413.53	19				

Two way ANOVA result showed that there is significant difference in the Potassium content between pre flood and post flood during post monsoon season (F=1054.239, P<0.05) (Table 2.2.21)

Table 2.2.22 : Two way ANOVA showing Potassium content of the soil at Pre- flood and Post-flood conditions during Summer monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	13.61663	4	3.404158	0.351699	0.837945	3.259167
Between Samples	33573.63	3	11191.21	1156.216	4.92E-15	3.490295
Error	116.15	12	9.679171			
Total	33703.39	19				

Two way ANOVA result showed that there is significant difference in the Potassium content between pre flood and post flood during summer season (F=1156.216, P<0.05) (Table 2.2.22)

CALCIUM

Table 2.2.23: Two way ANOVA showing Calcium content of the soil at Pre- flood and Post-flood conditions during Post monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	64.59022	4	16.14756	0.761342	0.570087	3.259167
Between Samples	669828.1	3	223276	10527.25	8.8E-21	3.490295
Error	254.5121	12	21.20934			
Total	670147.2	19				

Two way ANOVA result showed that there is significant difference in the Calcium content between pre flood and post flood during post monsoon season (F=10527.25, P<0.05) (Table 2.2.23)

Table 2.2.24 : Two way ANOVA showing Calcium content of the soil at Pre- flood and Post-flood conditions during Summer monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	41.96338	4	10.49084	0.390828	0.811299	3.259167
Between Samples	658903.9	3	219634.6	8182.32	3.99E-20	3.490295
Error	322.1111	12	26.84259			
Total	659268	19				

Two way ANOVA result showed that there is significant difference in the Calcium content between pre flood and post flood during summer season ($F=8182.32$, $P<0.05$) (Table 2.2.24)

MAGNESIUM

Table 2.2.25 : Two way ANOVA showing Magnesium content of the soil at Pre- flood and Post-flood conditions during Post monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	55.59702	4	13.89925	1.790562	0.195571	3.259167
Between Samples	33022.77	3	11007.59	1418.045	1.45E-15	3.490295
Error	93.15014	12	7.762512			
Total	33171.52	19				

Two way ANOVA result showed that there is significant difference in the Magnesium content between pre flood and post flood during post monsoon season ($F=1418.045$, $P<0.05$) (Table 2.2.25)

Table 2.2.26 : Two way ANOVA showing Magnesium content of the soil at Pre- flood and Post-flood conditions during Summer monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	70.68927	4	17.67232	2.777998	0.076107	3.259167
Between Samples	32134.59	3	10711.53	1683.798	5.19E-16	3.490295
Error	76.33837	12	6.361531			
Total	32281.62	19				

Two way ANOVA result showed that there is significant difference in the Magnesium content between pre flood and post flood during summer season (F=1683.798, P<0.05) (Table 2.2.26)

CHENGANNUR AREA

3.1 Soil physico-chemical parameters comparison between Pre- flood and Post-flood conditions during Post monsoon and summer Season

Temperature:

Table 2.3.1 : Two way ANOVA showing Temperature of the soil at Pre- flood and Post-flood conditions during Post monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	1.133	4	0.28325	6.866667	0.00409	3.259167
Between Samples	10.15	3	3.383333	82.0202	2.91E-08	3.490295
Error	0.495	12	0.04125			
Total	11.778	19				

Two way ANOVA result showed that there is significant difference in the temperature between pre flood and post flood during post monsoon season (F=82.0202, P<0.05) (Table 2.3.1)

Table 2.3.2 : Two way ANOVA showing Temperature of the soil at Pre- flood and Post-flood conditions during Summer monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	1.207	4	0.30175	0.87867	0.505128	3.259167
Between Samples	3.094	3	0.77438	4.805312	0.020119	3.490295
Error	4.121	12	0.343417			
Total	8.422	19				

Two way ANOVA result showed that there is significant difference in the temperature between pre flood and post flood during summer season (F=4.805312, P<0.05) (Table 2.3.2)

P^H

Table 2.3.3 : Two way ANOVA showing P^H of the soil at Pre- flood and Post-flood conditions during Post monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.18977	4	0.047443	2.188055	0.131988	3.259167
Between Samples	14.37666	3	4.79222	221.0179	9.18E-11	3.490295
Error	0.26019	12	0.021682			
Total	14.82662	19				

Two way ANOVA result showed that there is significant difference in the P^H between pre flood and post flood during post monsoon season ($F=221.0179$, $P<0.05$) (Table 2.3.3)

Table 2.3.4 : Two way ANOVA showing P^H of the soil at Pre- flood and Post-flood conditions during Summer monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.26423	4	0.066058	1.574266	0.243905	3.259167
Between Samples	44.7287	3	14.90957	355.321	5.55E-12	3.490295
Error	0.50353	12	0.041961			
Total	45.49646	19				

Two way ANOVA result showed that there is significant difference in the P^H between pre flood and post flood during summer season ($F=355.321$, $P<0.05$) (Table 2.3.4)

ORGANIC CARBON

Table 2.3.5 : Two way ANOVA showing Organic carbon of the soil at Pre- flood and Post-flood conditions during Post monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.05397	4	0.013493	1.141578	0.383359	3.259167
Between Samples	77.3721	3	25.7907	2182.108	1.1E-16	3.490295
Error	0.14183	12	0.011819			
Total	77.5679	19				

Two way ANOVA result showed that there is significant difference in the Organic carbon between pre flood and post flood during post monsoon season (F=2182.108, P<0.05) (Table 2.3.5)

Table 2.3.6 : Two way ANOVA showing OC of the soil at Pre- flood and Post-flood conditions during Summer monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.11503	4	0.028758	3.707058	0.034566	3.259167
Between Samples	62.15376	3	20.71792	2670.695	3.28E-17	3.490295
Error	0.09309	12	0.007757			
Total	62.36188	19				

Two way ANOVA result showed that there is significant difference in the Organic carbon between pre flood and post flood during summer season (F=2670.695, P<0.05) (Table 2.3.6)

EXCHANGEABLE ACID

Table 2.3.7: Two way ANOVA showing EA of the soil at Pre- flood and Post-flood conditions during Post monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	26.43762	4	6.609405	2.059906	0.149542	3.259167
Between Samples	189.9485	3	63.31618	19.7333	6.22E-05	3.490295
Error	38.50314	12	3.208595			
Total	254.8893	19				

Two way ANOVA result showed that there is significant difference in the EA between pre flood and post flood during post monsoon season (F=19.7333, P<0.05) (Table 2.3.7)

Table 2.3.8 : Two way ANOVA showing EA of the soil at Pre- flood and Post-flood conditions during Summer monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	16.85347	4	4.213368	0.742971	0.580856	3.259167
Between Samples	1536.198	3	512.0661	90.29601	1.68E-08	3.490295
Error	68.05165	12	5.670971			
Total	1621.103	19				

Two way ANOVA result showed that there is significant difference in the EA between pre flood and post flood during summer season (F=90.29601, P<0.05) (Table 2.3.8)

EXCHANGEABLE BASE

Table 2.3.9 : Two way ANOVA showing Temperature of the soil at Pre- flood and Post-flood conditions during Post monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.17545	4	0.043863	0.648926	0.638391	3.259167
Between Samples	22.03334	3	7.344447	108.6577	5.79E-09	3.490295
Error	0.81111	12	0.067592			
Total	23.0199	19				

Two way ANOVA result showed that there is significant difference in the EB between pre flood and post flood during post monsoon season (F=108.6577, P<0.05) (Table 2.3.9)

Table 2.3.10 : Two way ANOVA showing Temperature of the soil at Pre- flood and Post-flood conditions during Summer monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.313	4	0.07825	1.019721	0.435823	3.259167
Between Samples	20.17434	3	6.724778	87.63449	1.99E-08	3.490295
Error	0.92084	12	0.076737			
Total	21.40818	19				

Two way ANOVA result showed that there is significant difference in the EB between pre flood and post flood during post monsoon season (F=87.63449, P<0.05) (Table 2.3.10)

SAND

Table 2.3.11 : Two way ANOVA showing Sand content of the soil at Pre- flood and Post-flood conditions during Post monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	11.05077	4	2.762692	0.395576	0.808047	3.259167
Between Samples	66.532	3	22.17733	3.475458	0.043466	3.390295
Error	83.80775	12	6.983979			
Total	161.3905	19				

Two way ANOVA result showed that there is significant difference in the sand content between pre flood and post flood during post monsoon season (F=3.475458, P<0.05) (Table 2.3.11)

Table 2.3.12 : Two way ANOVA showing Sand content of the soil at Pre- flood and Post-flood conditions during Summer monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	23.73603	4	5.934008	0.977426	0.455612	3.259167
Between Samples	52.25146	3	17.41715	2.868883	0.040743	2.490295
Error	72.85269	12	6.071058			
Total	148.8402	19				

Two way ANOVA result showed that there is significant difference in the sand content between pre flood and post flood during summer season (F=2.868883, P<0.05) (Table 2.3.12)

SILT

Table 2.3.13 : Two way ANOVA showing Silt content of the soil at Pre- flood and Post-flood conditions during Post monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	3.32233	4	0.830582	1.746943	0.204404	3.259167
Between Samples	394.0397	3	131.3466	276.2579	2.46E-11	3.490295
Error	5.70539	12	0.475449			
Total	403.0675	19				

Two way ANOVA result showed that there is significant difference in the silt content between pre flood and post flood during post monsoon season ($F=276.2579$, $P<0.05$) (Table 2.3.13)

Table 2.3.14 : Two way ANOVA showing Silt content of the soil at Pre- flood and Post-flood conditions during Summer monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	5.66143	4	1.415358	0.819771	0.536906	3.259167
Between Samples	1251.725	3	417.2416	241.6652	5.43E-11	3.490295
Error	20.71833	12	1.726527			
Total	1278.105	19				

Two way ANOVA result showed that there is significant difference in the silt content between pre flood and post flood during summer season ($F=241.6652$, $P<0.05$) (Table 2.3.14)

CLAY

Table 2.3.15 : Two way ANOVA showing Clay content of the soil at Pre- flood and Post-flood conditions during Post monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.67253	4	0.168133	1.045151	0.424325	3.259167
Between Samples	30.67002	3	10.22334	63.55065	1.23E-07	3.490295
Error	1.93043	12	0.160869			
Total	33.27298	19				

Two way ANOVA result showed that there is significant difference in the clay content between pre flood and post flood during post monsoon season (F=63.55065, P<0.05) (Table 2.3.15)

Table 2.3.16 : Two way ANOVA showing Clay content of the soil at Pre- flood and Post-flood conditions during Summer monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.31018	4	0.077545	0.772733	0.56349	3.259167
Between Samples	23.73066	3	7.910218	78.82498	3.64E-08	3.490295
Error	1.20422	12	0.100352			
Total	25.24506	19				

Two way ANOVA result showed that there is significant difference in the clay content between pre flood and post flood during summer season (F=78.82498, P<0.05) (Table 2.3.16)

NITROGEN

Table 2.3.17 : Two way ANOVA showing Nitrogen content of the soil at Pre- flood and Post-flood conditions during Post monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	1651.318	4	412.8294	0.816748	0.538582	3.259167
Between Samples	8734185	3	2911395	5759.945	3.27E-19	3.490295
Error	6065.464	12	505.4554			
Total	8741902	19				

Two way ANOVA result showed that there is significant difference in the Nitrogen content between pre flood and post flood during post monsoon season (F=5759.945, P<0.05) (Table 2.3.17)

Table 2.3.18 : Two way ANOVA showing Nitrogen content of the soil at Pre- flood and Post-flood conditions during Summer monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	857.8671	4	214.4668	1.599138	0.237737	3.259167
Between Samples	10389692	3	3463231	25823.04	4.05E-23	3.490295
Error	1609.368	12	134.114			
Total	10392159	19				

Two way ANOVA result showed that there is significant difference in the Nitrogen content between pre flood and post flood during summer season ($F=25823.04$, $P<0.05$) (Table 2.3.18)

PHOSPHORUS

Table 2.3.19 : Two way ANOVA showing Phosphorus content of the soil at Pre- flood and Post-flood conditions during Post monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.12415	4	0.031038	0.559259	0.696612	3.259167
Between Samples	81.50098	3	27.16699	489.5174	8.28E-13	3.490295
Error	0.66597	12	0.055498			
Total	82.2911	19				

Two way ANOVA result showed that there is significant difference in the Phosphorus content between pre flood and post flood during post monsoon season ($F=489.5174$, $P<0.05$) (Table 2.3.19)

Table 2.3.20 : Two way ANOVA showing Phosphorus content of the soil at Pre- flood and Post-flood conditions during Summer monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	0.07792	4	0.01948	0.363953	0.829638	3.259167
Between Samples	41.41372	3	13.80457	257.9169	3.7E-11	3.490295
Error	0.64228	12	0.053523			
Total	42.13392	19				

Two way ANOVA result showed that there is significant difference in the Phosphorus content between pre flood and post flood during summer season (F=257.9169, P<0.05) (Table 2.3.20)

POTASSIUM

Table 2.3.21 : Two way ANOVA showing Potassium content of the soil at Pre- flood and Post-flood conditions during Post monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	67.12783	4	16.78196	1.874502	0.179731	3.259167
Between Samples	60693.22	3	20231.07	2259.759	8.92E-17	3.490295
Error	107.4331	12	8.952758			
Total	60867.78	19				

Two way ANOVA result showed that there is significant difference in the Potassium content between pre flood and post flood during post monsoon season (F=2259.759, P<0.05) (Table 2.3.21)

Table 2.3.22 : Two way ANOVA showing Potassium content of the soil at Pre- flood and Post-flood conditions during Summer monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	76.76218	4	19.19054	1.473171	0.270813	3.259167
Between Samples	56506.09	3	18835.36	1445.905	1.29E-15	3.490295
Error	156.3203	12	13.0267			
Total	56739.17	19				

Two way ANOVA result showed that there is significant difference in the Potassium content between pre flood and post flood during summer season (F=1445.905, P<0.05) (Table 2.3.22)

CALCIUM

Table 2.3.23 : Two way ANOVA showing Calcium content of the soil at Pre- flood and Post-flood conditions during Post monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	67.33007	4	16.83252	0.861929	0.513989	3.259167
Between Samples	960777.3	3	320259.1	16399.26	6.17E-22	3.490295
Error	234.3466	12	19.52888			
Total	961079	19				

Two way ANOVA result showed that there is significant difference in the Calcium content between pre flood and post flood during post monsoon season ($F=16399.26$, $P<0.05$) (Table 2.3.23)

Table 2.3.24: Two way ANOVA showing Calcium content of the soil at Pre- flood and Post-flood conditions during Summer monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	126.1496	4	31.53741	1.852524	0.183736	3.259167
Between Samples	806580.1	3	268860	15792.98	7.73E-22	3.490295
Error	204.2882	12	17.02402			
Total	806910.6	19				

Two way ANOVA result showed that there is significant difference in the Calcium content between pre flood and post flood during summer season ($F=15792.98$, $P<0.05$) (Table 2.3.24)

MAGNESIUM

Table 2.3.25 : Two way ANOVA showing Magnesium content of the soil at Pre- flood and Post-flood conditions during Post monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	21.78722	4	5.446805	0.417902	0.792723	3.259167
Between Samples	48674.64	3	16224.88	1244.843	3.16E-15	3.490295
Error	156.4041	12	13.03368			
Total	48852.83	19				

Two way ANOVA result showed that there is significant difference in the Magnesium content between pre flood and post flood during post monsoon season (F=1244.843, P<0.05) (Table 2.3.25)

Table 2.3.26 : Two way ANOVA showing Magnesium content of the soil at Pre- flood and Post-flood conditions during Summer monsoon

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Samples	147.5776	4	36.89441	6.046891	0.006662	3.259167
Between Samples	44362.91	3	14787.64	2423.653	5.86E-17	3.490295
Error	73.21661	12	6.101384			
Total	44583.71	19				

Two way ANOVA result showed that there is significant difference in the Magnesium content between pre flood and post flood during summer season (F=2423.653, P<0.05) (Table 2.3.26)

POPULATION DENSITY OF SOIL BIOTA NEAR PAMPA RIVER DURING PRE FLOOD AND POST FLOOD

RANNI AREA

3.1 Population density of soil micro arthropods during post monsoon season- pre flood

Eleven groups of soil animals were recorded from the study sites during post monsoon season. They were acari, diplopoda, isopoda, annelida, collembola, hymenoptera, isoptera, orthoptera, coleoptera, gastropoda and pauropoda. Collembolans were the most abundant group where as Gastropoda and orthoptera were least abundant (Table 3.1.1).

Table 3.1.1 : Population density of soil micro arthropods during post monsoon season (Pre flood) (Mean ± S.E per m^2)

Soil Biota	Ayiroor	Ranni	Chettakkal	Cherukolpuzha	Perunad	Mean±SE
Acari	40	45	41	38	41	41±2.549
Diplopoda	30	31	28	34	38	32.2±3.898
Isopoda	25	29	24	20	28	25.2±3.563
Annelida	10	15	19	9	10	12.6±4.277
Collembola	38	43	42	38	40	40.2±2.280
Hymenoptera	24	20	20	28	21	22.6±3.143
Isoptera	3	1	0	2	0	1.2±1.303
Orthoptera	0	0	0	2	0	0.4±0.894
Coleoptera	2	5	3	0	2	2.4±1.816
Gastropoda	0	0	0	1	2	0.6±0.894
Pauropoda	9	5	4	3	5	5.2±2.280

Table 3.1.2 : Two way ANOVA showing the population density of soil micro arthropods during post monsoon season

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Groups	12238.32727	10	1223.833	89.80161	3.56E-24	2.077248
Between Groups	55.27272727	4	13.81818	1.013942	0.411762	2.605975
Error	545.1272727	40	13.62818			
Total	12838.72727	54				

Two way ANOVA conducted revealed that there is significant difference in the population density of different groups of animals ($F = 89.80161$, $P < 0.05$) and no significant difference between the density of same group of animals at different sites ($F = 1.013942$, $P > 0.05$) (Table 3.1.2).

3.2 Population density of soil micro arthropods during post monsoon season- post flood

During post flood season isopoda, collembolan, isopteran, orthoptera, gastropoda, pauropoda and coleoptera were not at all represented in the sample in all sites. Here Acari, diplopoda and hymenoptera were least represented (Table 3.2.1).

Table 3.2.1: Population density of soil micro arthropods during post monsoon season (Post flood) (Mean ± S.E per m^2)

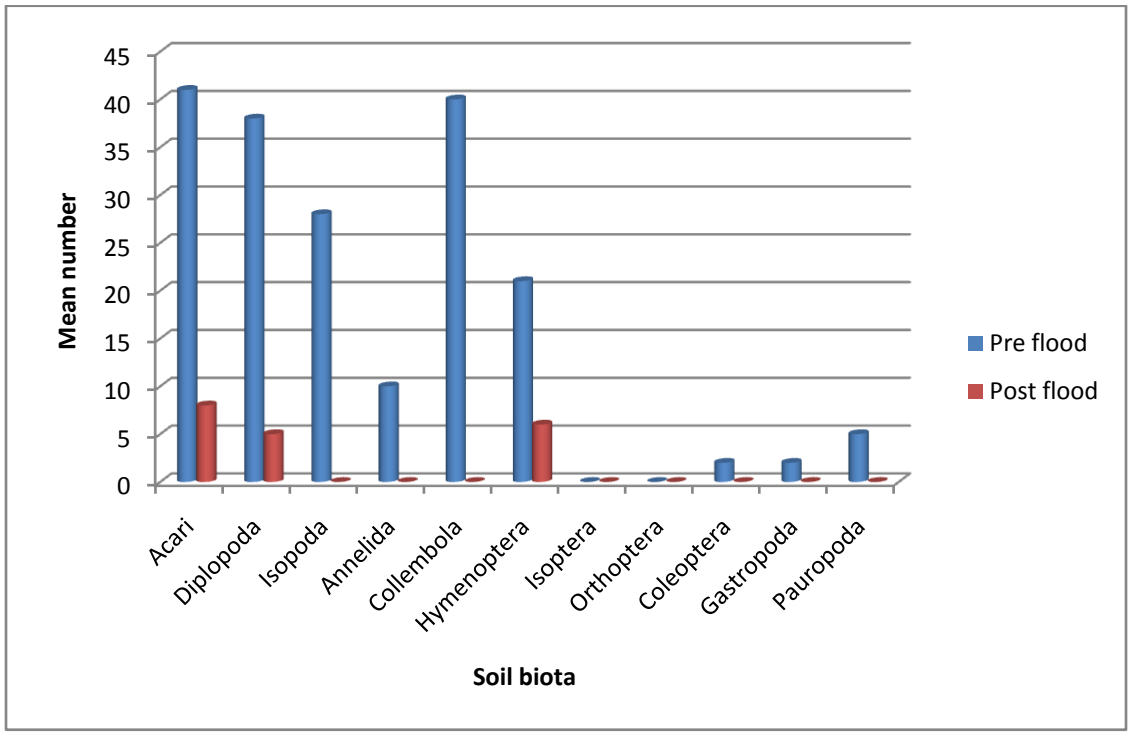
Soil fauna	Ayiroor	Ranni	Chettakkal	Cherukolpuzha	Perunad	Mean±SE
Acari	13	10	9	12	8	10.4±2.07
Diplopoda	10	6	6	8	5	7±2
Isopoda	0	0	0	0	0	0±0
Annelida	3	0	1	0	0	0.8±1.3
Collembola	0	0	0	0	0	0±0
Hymenoptera	9	3	5	6	6	5.8±2.16
Isoptera	0	0	0	0	0	0±8
Orthoptera	0	0	0	0	0	0±0
Coleoptera	0	0	0	0	0	0±0
Gastropoda	0	0	0	0	0	0±0
Pauropoda	0	0	0	0	0	0±0

Table 3.2.2 : Two way ANOVA showing the population density of soil micro arthropods during post monsoon season

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Groups	695.3818	10	69.53818	66.11236	1.13E-21	2.077248
Between Groups	16.72727	4	4.181818	3.975799	0.008277	2.605975
Error	42.07273	40	1.051818			
Total	754.1818	54				

A Two Way ANOVA conducted showed that there is significant difference in the population density of different animal groups ($F = 66.11236$, $P < 0.05$) whereas no significant difference was found in the density of same animal groups at different sites ($F = 3.975799$, $P > 0.05$) (Table 3.2.2).

Fig. 3.1: Population density of soil biota in Ranni area during post monsoon season (Before flood and after flood)



3.3 Population density of soil micro arthropods during Summer season- pre flood

Table 3.3.1: Population density of soil micro arthropods during Summer season (Pre flood) (Mean ± S.E per m^2)

Soil fauna	Ayiroor	Ranni	Chettakkal	Cherukolpuzha	Perunad	Mean±SE
Acari	24	30	25	27	32	27.6±3.361
Diplopoda	18	20	15	24	20	19.4±3.286
Isopoda	12	15	18	20	16	16.2±3.033
Annelida	6	8	10	5	8	7.4±1.949
Collembola	30	34	35	30	38	33.4±3.435
Hymenoptera	18	24	20	21	15	19.6±3.361
Isoptera	0	5	2	0	0	1.4±2.190
Orthoptera	3	0	2	3	0	1.6±1.516
Coleoptera	0	3	0	2	1	1.2±1.303
Gastropoda	0	3	2	0	3	1.6±1.516
Pauropoda	2	5	4	3	5	3.8±1.303

Eleven groups of soil animals were recorded from the study sites during post monsoon season. They were acari, diplopoda, isopoda, annelida, collembola, hymenoptera, isoptera, orthoptera, coleoptera, gastropoda and pauropoda. Collembolans and acari were the most abundant group where as isopteran, orthoptera, coleopteran and Gastropoda were least abundant (Table 3.3.1).

Table 3.3.2 : Two way ANOVA showing the population density of soil micro arthropods during Summer season

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Groups	6825.345	10	682.5345	120.1645	1.36E-26	2.077248
Between Groups	56.8	4	14.2	2.5	0.057646	2.605975
Error	227.2	40	5.68			
Total	7109.345	54				

Two way ANOVA conducted revealed that there is significant difference in the population density of different groups of animals ($F = 120.1645$, $P < 0.05$) and no significant difference between the density of same group of animals at different sites ($F = 2.5$, $P > 0.05$) (Table 3.3.2).

3.4 Population density of soil micro arthropods during Summer season- post flood

Table 3.4.1: Population density of soil micro arthropods during Summer season (Post flood) (Mean ± S.E per m^2)

Soil fauna	Ayiroor	Ranni	Chettakkal	Cherukolpuzha	Perunad	Mean±SE
Acari	10	8	7	5	8	7.6±1.816
Diplopoda	9	6	5	5	6	6.2±1.643
Isopoda	0	0	0	0	0	0±0
Annelida	1	0	0	0	0	0.2±0.447
Collembola	0	0	0	0	0	0±0
Hymenoptera	8	5	4	7	5	5.8±1.643
Isoptera	0	0	0	0	0	0±0
Orthoptera	0	0	0	0	0	0±0
Coleoptera	0	0	0	0	0	0±0
Gastropoda	0	0	0	0	0	0±0
Pauropoda	0	0	0	0	0	0±0

During post flood season isopoda, collembola, isoptera, orthoptera, gastropoda, pauropoda and coleoptera were not at all represented in the sample in all sites. (Table 3.4.1)

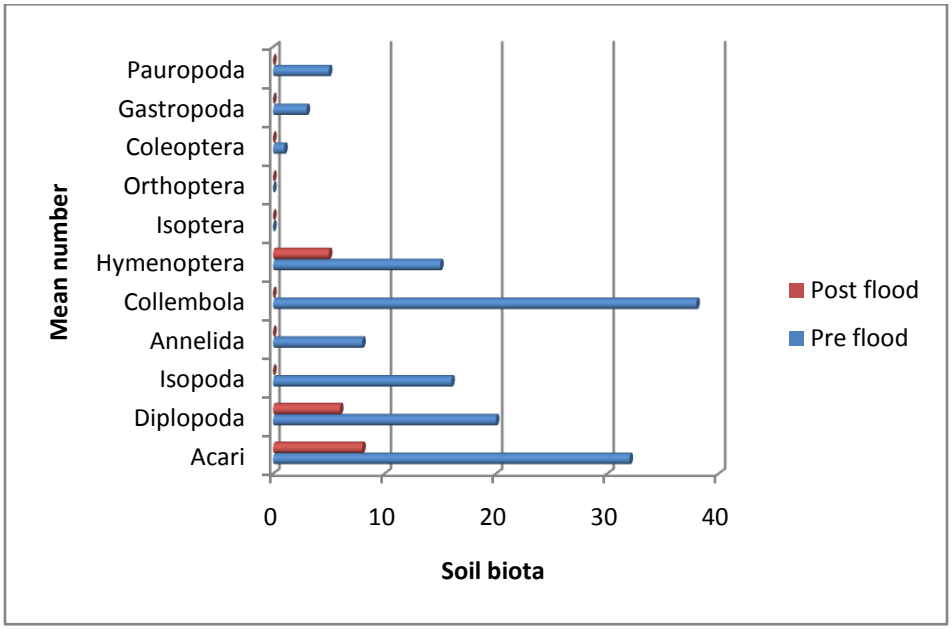
Table 3.4.2 : Two way ANOVA showing the population density of soil micro arthropods during Summer season

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Groups	471.2	10	47.12	68.92553	5.21E-22	2.077248
Between Groups	8.254545	4	2.063636	3.018617	0.028826	2.605975
Error	27.34545	40	0.683636			
Total	506.8	54				

Two way ANOVA conducted revealed that there is significant difference in the population density of different groups of animals ($F = 68.92553$, $P < 0.05$) and also significant

difference between the density of same group of animals at different sites (F =3.018617, P< 0.05) (Table 3.4.2).

Fig. 3.2: Population density of soil biota in Ranni area during summer season (Before flood and after flood)



KOZHENCHERRY AREA

3.5 Population density of soil micro arthropods during post monsoon season- pre flood

Nine groups of soil animals were recorded from the study sites during post monsoon season. They were acari, diplopoda, isopoda, annelida, collembola, hymenoptera, isoptera, gastropoda and pauropoda. Acari were the most abundant group where as isopteran and pauropoda were least abundant (Table 3.5.1).

Table 3.5.1 : Population density of soil micro arthropods during Post monsoon season (Pre flood) (Mean ± S.E per m^2)

Soil fauna	Aranmula	Neervilakkom	Koyipuram	Arattupuzha	Malakkara	Mean±SE
Acari	45	52	42	42	40	44.2±4.711
Diplopoda	30	37	35	32	30	32.8±3.114
Isopoda	24	20	27	25	24	24±2.549
Annelida	15	20	19	23	16	18.6±3.209
Collembola	33	38	35	40	34	36±2.915
Hymenoptera	12	16	20	14	20	16.4±3.577
Isoptera	0	2	0	0	0	0.4±0.894
Orthoptera	0	0	0	0	0	0±0
Coleoptera	0	0	0	0	0	0±0
Gastropoda	6	10	8	5	4	6.6±2.408
Pauropoda	3	5	7	3	3	4.2±1.788

Table 3.5.2 : Two way ANOVA showing the population density of soil micro arthropods during Post monsoon season

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Groups	12676	10	1267.6	172.037	1.31E-29	2.077248
Between Groups	98.07273	4	24.51818	3.327576	0.019172	2.605975
Error	294.7273	40	7.368182			
Total	13068.8	54				

Two way ANOVA conducted revealed that there is significant difference in the population density of different groups of animals ($F = 172.037$, $P < 0.05$) and also significant difference between the density of same group of animals at different sites ($F = 3.327576$, $P > 0.05$) (Table 3.5.2).

3.6 Population density of soil micro arthropods during post monsoon season- post flood

Table 3.6.1 : Population density of soil micro arthropods during Post monsoon season (Post flood) (Mean ± S.E per m^2)

Soil fauna	Aranmula	Neervilakkom	Koyipuram	Arattupuzha	Malakkara	Mean±SE
Acari	11	9	10	10	8	9.6±1.140
Diplopoda	6	6	9	7	10	7.6±1.816
Isopoda	0	0	0	0	0	0±0
Annelida	2	0	0	0	0	0.4±0.894
Collembola	0	0	0	0	0	0±0
Hymenoptera	6	5	5	5	5	5.2±0.447
Isoptera	0	0	0	0	0	0±0
Orthoptera	0	0	0	0	0	0±0
Coleoptera	0	0	0	0	0	0±0
Gastropoda	0	0	0	0	0	0±0
Pauropoda	0	0	0	0	0	0±0

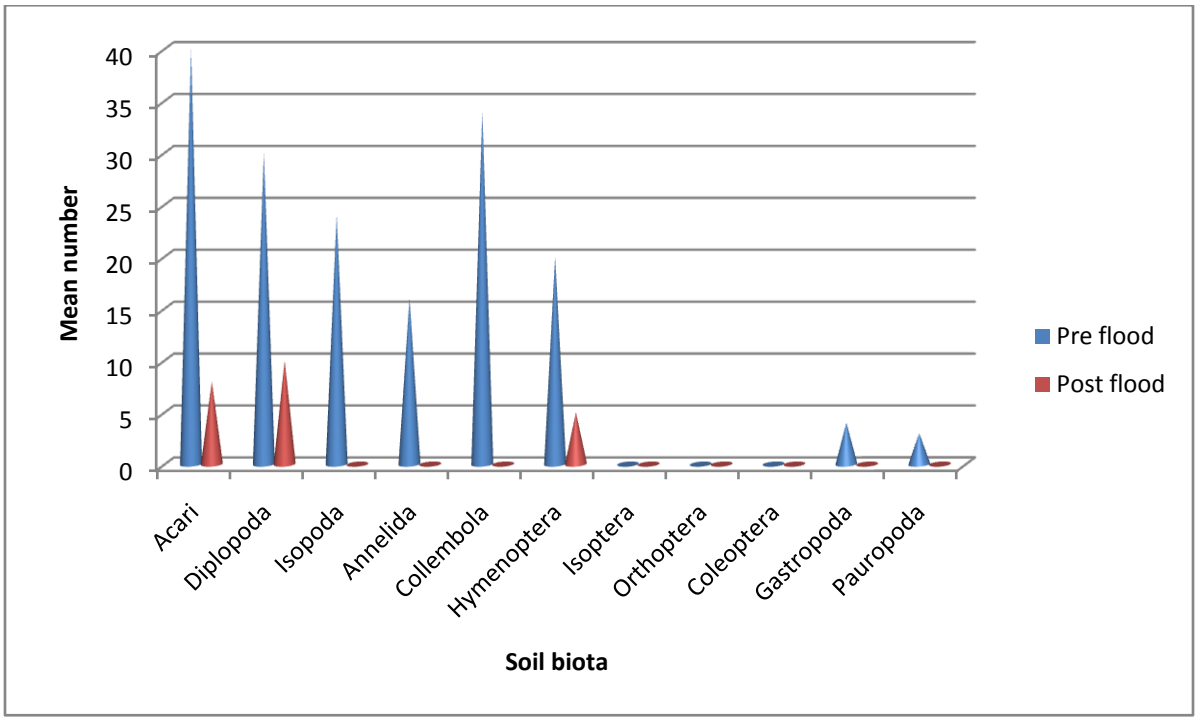
During post flood season isopoda, collembola, isoptera, orthoptera, gastropoda, pauropoda and coleoptera were not at all represented in the sample in all sites. Here Acari, diplopoda, Annelida and hymenoptera were least represented (Table 3.6.1).

Table 3.6.2 : Two way ANOVA showing the population density of soil micro arthropods during Post monsoon season

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Groups	649.3091	10	64.93091	123.3575	8.21E-27	2.077248
Between Groups	1.345455	4	0.336364	0.639033	0.637729	2.605975
Error	21.05455	40	0.526364			
Total	671.7091	54				

Two way ANOVA conducted revealed that there is significant difference in the population density of different groups of animals ($F = 123.3575$, $P < 0.05$) and no significant difference between the density of same group of animals at different sites ($F = 0.639033$, $P > 0.05$) (Table 3.6.2).

Fig. 3.3: Population density of soil biota in Kozhenchery area during post monsoon season (Before flood and after flood)



3.7 Population density of soil micro arthropods during Summer season- pre flood

Eleven groups of soil animals were recorded from the study sites during post monsoon season. They were acari, diplopoda, isopoda, annelida, collembola, hymenoptera, isoptera, orthoptera, coleoptera, gastropoda and pauropoda. Collembolans were the most abundant group (Table 3.7.1)

Table 3.7.1: Population density of soil micro arthropods during Summer season (Pre flood) (Mean ± S.E per m^2)

Soil Biota	Aranmula	Neervilakkom	Koyipuram	Arattupuzha	Malakkara	Mean±SE
Acari	24	30	28	27	30	27.8±2.227
Diplopoda	18	25	22	27	25	23.4±3.136
Isopoda	12	20	18	15	13	15.6±3.006
Annelida	3	8	9	7	5	6.4±2.154
Collembola	43	40	48	43	40	42.8±2.925
Hymenoptera	24	30	22	27	25	25.6±2.727
Isoptera	0	5	0	0	3	1.6±2.059
Orthoptera	3	0	2	2	0	1.4±1.2
Coleoptera	0	3	0	0	0	0.6±1.2
Gastropoda	0	1	3	0	0	0.8±1.166
Pauropoda	3	7	5	3	2	4±1.788

Table 3.7.2 : Two way ANOVA showing the population density of soil micro arthropods during Post monsoon season

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Groups	9612.4	10	961.24	155.7466	9.06E-29	2.077248
Between Groups	115.9273	4	28.98182	4.695831	0.003348	2.605975
Error	246.8727	40	6.171818			
Total	9975.2	54				

Two way ANOVA conducted revealed that there is significant difference in the population density of different groups of animals ($F = 155.7466$, $P < 0.05$) and also significant difference between the density of same group of animals at different sites ($F = 4.695831$, $P > 0.05$) (Table 3.7.2).

3.8 Population density of soil micro arthropods during Summer season- post flood

Four groups of soil animals were recorded from the study sites during post monsoon season. They were acari, diplopoda, annelida, hymenoptera. (Table 3.8.1)

Table 3.8.1: Population density of soil micro arthropods during Summer season (Post flood) (Mean ± S.E per m^2)

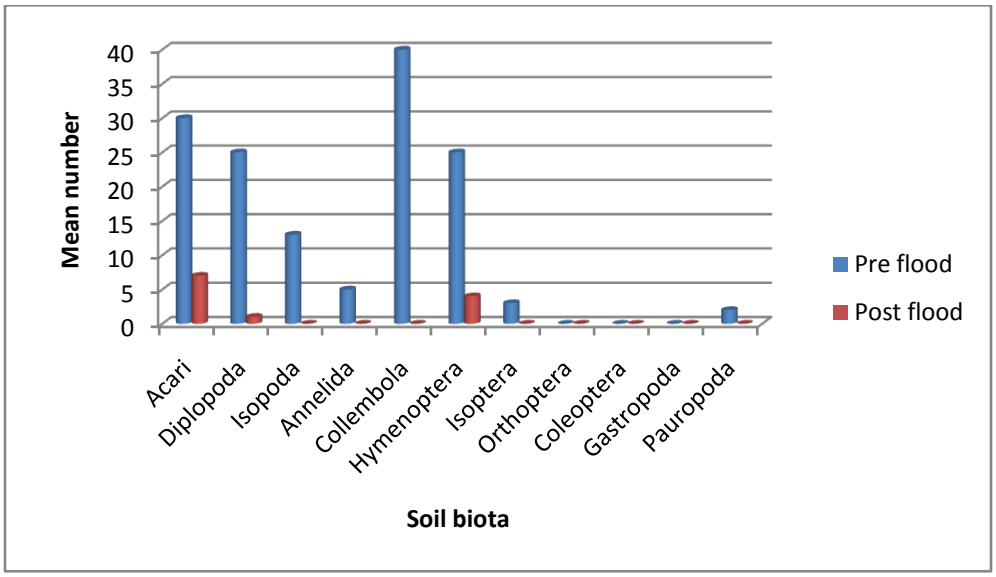
Soil fauna	Aranmula	Neervilakkom	Koyipuram	Arattupuzha	Malakkara	Mean±SE
Acari	9	7	8	10	7	8.2±1.303
Diplopoda	7	5	5	4	1	4.4±2.190
Isopoda	0	0	0	0	0	0±0
Annelida	1	0	0	0	0	0.2±0.447
Collembola	0	0	0	0	0	0±0
Hymenoptera	6	5	7	3	4	5±1.58
Isoptera	0	0	0	0	0	0±0
Orthoptera	0	0	0	0	0	0±0
Coleoptera	0	0	0	0	0	0±0
Gastropoda	0	0	0	0	0	0±0
Pauropoda	0	0	0	0	0	0±0

Table 3.8.2 : Two way ANOVA showing the population density of soil micro arthropods during Post monsoon season

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Groups	414.1818	10	41.41818	53.91716	4.93E-20	2.077248
Between Groups	6.072727	4	1.518182	1.976331	0.11669	2.605975
Error	30.72727	40	0.768182			
Total	450.9818	54				

Two way ANOVA conducted revealed that there is significant difference in the population density of different groups of animals ($F = 53.91716$, $P < 0.05$) and no significant difference between the density of same group of animals at different sites ($F = 1.976331$, $P > 0.05$) (Table 3.8.2).

Fig. 3.4: Population density of soil biota in Kozhenchery area during summer season (Before flood and after flood)



CHENGANNUR AREA

3.9 Population density of soil micro arthropods during post monsoon season- pre flood

Ten groups of soil animals were recorded from the study sites during post monsoon season. They were acari, diplopoda, isopoda, annelida, collembola, hymenoptera, isoptera, gastropoda and pauropoda. Acari and diplopoda were the most abundant group (Table 3.9.1).

Table 3.9.1 : Population density of soil micro arthropods during Post monsoon season (Pre flood) (Mean ± S.E per m^2)

Soil fauna	Chengannur	Pandanad	Thiruvanvandoor	Venmony	Ala	Mean ±SE
Acari	30	35	38	40	36	35.8±3.768
Diplopoda	27	25	22	31	24	25.8±3.420
Isopoda	12	15	16	11	15	13.8±2.167
Annelida	21	20	20	25	24	22±2.345
Collembola	39	42	45	42	43	42.2±2.167
Hymenoptera	15	20	25	20	20	20±3.525
Isoptera	0	0	3	2	3	1.6±1.516
Orthoptera	0	0	0	0	0	0±0
Coleoptera	0	0	5	0	2	1.4±2.190
Gastropoda	0	0	0	2	1	0.6±0.894
Pauropoda	3	5	4	1	5	3.6±1.673

Table 3.9.2 : Two way ANOVA showing the population density of soil micro arthropods during Post monsoon season

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Groups	11098.8	10	1109.88	187.8837	2.35E-30	2.077248
Between Groups	44.90909	4	11.22727	1.900585	0.129203	2.605975
Error	236.2909	40	5.907273			
Total	11380	54				

Two way ANOVA conducted revealed that there is significant difference in the population density of different groups of animals ($F = 187.8837$, $P < 0.05$) and no significant difference between the density of same group of animals at different sites ($F = 1.900585$, $P > 0.05$) (Table 3.9.2).

3.10 Population density of soil micro arthropods during post monsoon season- post flood

During post flood season isopoda, collembola, isoptera, orthoptera, gastropoda, pauropoda and coleoptera were not at all represented in the sample in all sites. Here Acari, diplopoda, Annelida and hymenoptera were least represented (Table 3.10.1).

Table 3.10.1 : Population density of soil micro arthropods during Post monsoon season (Post flood) (Mean ± S.E per m^2)

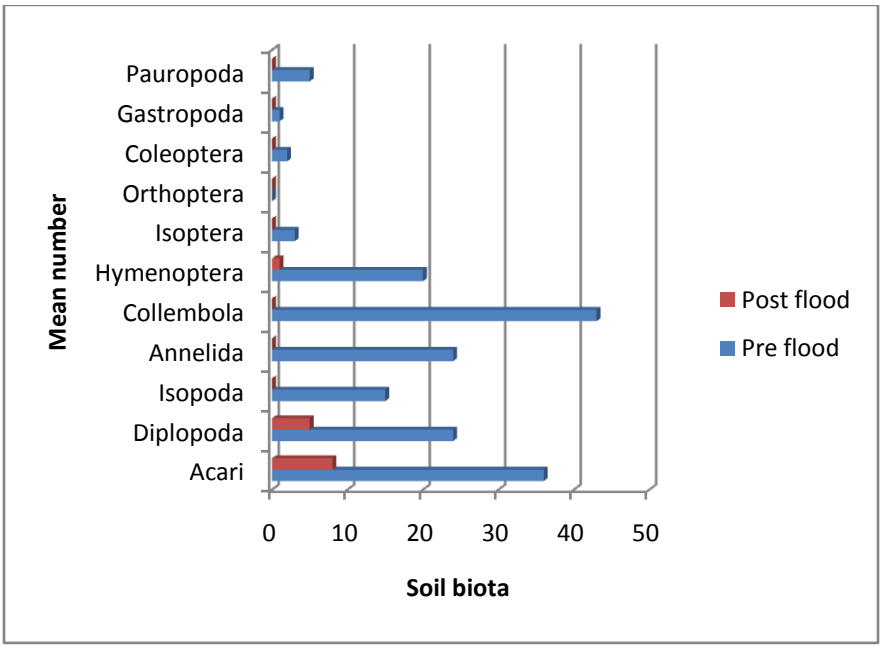
Soil fauna	Chengannur	Pandanad	Thiruvanvandoor	Venmony	Ala	Mean±SE
Acari	11	10	8	9	8	9.2±1.303
Diplopoda	12	7	8	9	5	8.2±2.588
Isopoda	0	0	0	0	0	0±0
Annelida	1	2	0	0	0	0.6±0.894
Collembola	0	0	0	0	0	0±0
Hymenoptera	2	5	3	4	1	3±1.581
Isoptera	0	0	0	**0**	0	0±0
Orthoptera	0	0	0	0	0	0±0
Coleoptera	0	0	0	0	0	0±0
Gastropoda	0	0	0	0	0	0±0
Pauropoda	0	0	0	0	0	0±0

Table 3.10.2 : Two way ANOVA showing the population density of soil micro arthropods during Post monsoon season

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Groups	605.7455	10	60.57455	62.44799	3.28E-21	2.077248
Between Groups	8	4	2	2.061856	0.103997	2.605975
Error	38.8	40	0.97			
Total	652.5455	54				

Two way ANOVA conducted revealed that there is significant difference in the population density of different groups of animals (F =62.44799, P< 0.05) and no significant difference between the density of same group of animals at different sites (F =2.061856, P> 0.05) (Table 3.10.2).

Fig. 3.5: Population density of soil biota in Chengannur area during post monsoon season (Before flood and after flood)



3.11 Population density of soil micro arthropods during summer season- pre flood

Eleven groups of soil animals were recorded from the study sites during post monsoon season. They were acari, diplopoda, isopoda, annelida, collembola, hymenoptera, isoptera, orthoptera, coleopteran, gastropoda and pauropoda. (Table 3.11.1).

Table 3.11.1 : Population density of soil micro arthropods during Summer season (Pre flood) (Mean ± S.E per m^2)

Soil fauna	Chengannur	Pandanad	Thiruvanvandoor	Venmony	Ala	Mean±SE
Acari	18	25	20	20	25	21.6±3.209
Diplopoda	21	27	24	28	2	20.4±10.64
Isopoda	6	8	10	15	8	9.4±3.45
Annelida	9	15	13	8	10	11±2.915
Collembola	27	24	25	20	31	25.4±4.037
Hymenoptera	12	18	15	12	18	15±3
Isoptera	3	3	1	0	0	1.4±1.516
Orthoptera	0	2	2	0	3	1.4±1.341
Coleoptera	0	0	0	2	3	1±1.414
Gastropoda	0	2	3	0	2	1.4
Pauropoda	3	4	3	2	2	2.8

Table 3.11.2 : Two way ANOVA showing the population density of soil micro arthropods during Summer season

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Groups	4193.782	10	419.3782	24.15773	6.66E-14	2.077248
Between Groups	52.8	4	13.2	0.760369	0.557268	2.605975
Error	694.4	40	17.36			
Total	4940.982	54				

Two way ANOVA conducted revealed that there is significant difference in the population density of different groups of animals ($F = 24.15773$, $P < 0.05$) and no significant difference between the density of same group of animals at different sites ($F = 0.760369$, $P > 0.05$) (Table 3.11.2).

3.12 Population density of soil micro arthropods during summer season- post flood

Table 3.12.1 : Population density of soil micro arthropods during Summer season (Post flood) (Mean ± S.E per m^2)

Soil fauna	Chengannur	Pandanad	Thiruvanvandoor	Venmony	Ala	Mean±SE
Acari	5	3	0	0	0	1.6±2.302
Diplopoda	8	8	6	4	0	5.2±3.346
Isopoda	0	0	0	0	0	0±0
Annelida	2	2	3	0	1	1.6±1.140
Collembola	0	0	0	0	0	0±0
Hymenoptera	3	5	3	2	5	3.6±
Isoptera	0	0	0	0	0	0±0
Orthoptera	0	0	0	0	0	0±0
Coleoptera	0	0	0	0	0	0±0
Gastropoda	0	0	0	0	0	0±0
Pauropoda	0	0	0	0	0	0±0

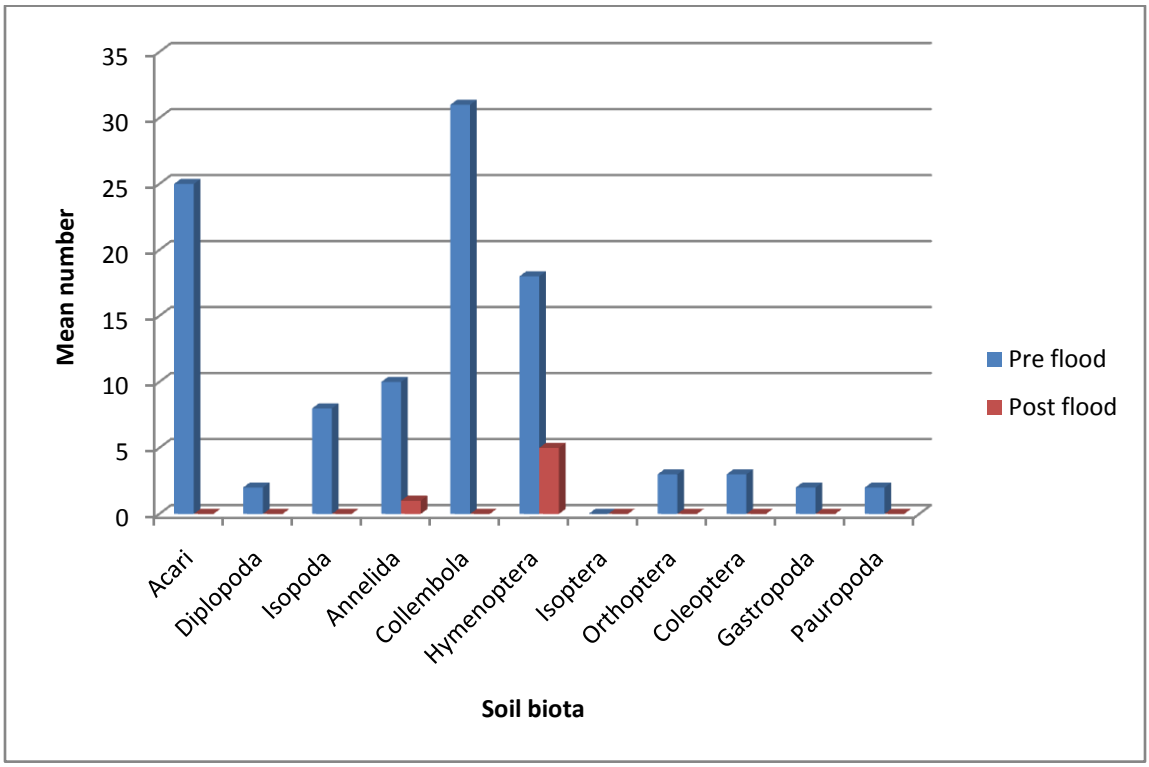
During post flood season isopoda, collembola, isoptera, orthoptera, gastropoda, pauropoda and coleoptera were not at all represented in the sample in all sites. Here Acari, diplopoda, Annelida and hymenoptera were least represented (Table 3.12.1).

Table 3.12.2 : Two way ANOVA showing the population density of soil micro arthropods during Summer season

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Within Groups	160.1455	10	16.01455	9.808463	5.07E-08	2.077248
Between Groups	13.09091	4	3.272727	2.004454	0.112355	2.605975
Error	65.30909	40	1.632727			
Total	238.5455	54				

Two way ANOVA conducted revealed that there is significant difference in the population density of different groups of animals ($F = 9.808463$, $P < 0.05$) and no significant difference between the density of same group of animals at different sites ($F = 2.004454$, $P > 0.05$) (Table 3.12.2

Fig. 3.5: Population density of soil biota in Chengannur area during summer season (Before flood and after flood)



SOIL PROPERTIES AND PRINCIPAL COMPONENT ANALYSIS

RANNI AREA

BEFORE FLOOD

The Principal Component analysis showed that during post monsoon sseason, soil edaphic factors such as temperature, Exchangeable Acid, Nitrogen, Phosphorus, Potassium, Calcium and Magnesium content primarily controls the density of Diplopoda, Isopoda, Annelida, Orthoptera, Gastropoda and Pauropoda (Table 4.1)

Table 4.1: Principal Component analysis showing the influence of soil parameters on the density of soil biota during post monsoon in Ranni area (Before flood)

Variable	PC1	PC2	PC3
Temperature	0.2386	0.16489	0.13641
p^H	-0.22947	-0.16137	0.19985
OC	-0.26426	0.10797	-0.0254
EA	0.05535	0.18431	0.40863
EB	-0.13305	-0.17615	-0.20949
Sand	-0.18946	0.28391	-0.12078
Silt	-0.23281	-0.10217	-0.17976
Clay	-0.19042	0.24334	-0.00059
Moisture	-0.25442	0.09151	-0.15446
N	0.23603	0.10235	0.19506
P	0.10375	0.33188	-0.21964
K	0.15196	0.19204	-0.32561
Ca	0.12746	-0.36065	0.05267
Mg	0.20543	-0.19521	-0.18543

During summer season, temperature, sand, clay, Nitrogen, Potassium, Calcium and Magnesium were the principal factors controlling the density of Isopoda, Annelida, Hymenoptera, Orthoptera, Coleoptera and Pauropoda as per the PCA analysis. pH, EA, silt, moisture and Nitrogen were the second principal factors controlling the distribution of Diplopoda, Isopoda, Annelida, Collembola and Hymenoptera. (Table 4.2)

Table 4.2: Principal Component analysis showing the influence of soil parameters on the density of soil biota during summer season in Ranni area (Before flood)

Variable	PC1	PC2	PC3
Temperature	0.22474	0.06569	0.04605
p^H	-0.25201	0.16507	0.00518
OC	-0.23515	-0.22887	0.0982
EA	-0.09572	0.32966	0.1667
EB	0.21021	-0.12715	0.16656
Sand	0.0834	-0.31063	-0.19211
Silt	-0.02296	0.33022	-0.15227
Clay	0.10734	0.22528	0.21552
Moisture	-0.27886	0.15195	0.09592
N	0.03054	0.00669	0.45931
P	-0.23767	-0.19849	0.19727
K	0.26091	-0.12194	-0.00621
Ca	0.02001	-0.33408	0.11481
Mg	0.03243	0.27802	-0.28742

AFTER FLOOD

Temperature, Sand, moisture, potassium, calcium and magnesium were the principal factors affecting the density of Acari, Collembola and Hymenoptera during post monsoon season (Table 4.3). Temperature, OC, EA, EB and Sand are the second principal factors affecting the density of Acari, Diplopoda, Isopoda, Coleoptera and Pauropoda. (Table 4.3)

Table 4.3: Principal Component analysis showing the influence of soil parameters on the density of soil biota during post monsoon season in Ranni area (after flood)

Variable	PC1	PC2	PC3
Temperature	0.10049	0.20188	0.48503
p^H	-0.28813	-0.12806	0.25433
OC	-0.12059	0.42935	-0.12836
EA	-0.28099	0.06163	-0.23424
EB	-0.00133	0.3006	-0.3462
Sand	0.08013	0.09314	-0.45424
Silt	-0.242	-0.32788	0.11707
Clay	-0.13156	-0.43402	-0.07138
Moisture	0.2481	-0.03316	-0.08965
N	-0.24619	-0.16486	0.12226
P	0.2406	-0.25029	-0.26171
K	-0.11599	-0.35608	-0.31217
Ca	0.3272	-0.116	0.06509
Mg	0.26098	-0.23338	-0.00621

From principal component analysis, it could be observed that temperature, p^H , EA, EB, moisture, Nitrogen, Potassium and Calcium were the primary principal factors affecting density of Isopoda, Annelida, Hymenoptera, Orthoptera, Gastropoda and Pauropoda during post monsoon inRanni area. Second principal factors affecting density of Collembola, Hymenoptera, isoptera and Coleoptera are found to be EA, EB, clay, moisture, Nitrogen, Phosphorus and potassium. Density of Diplopoda, Isoptera, Annelida, Collembola and Hymenoptera are found to be affected by a set of third principal factors such silt, clay, Magnesium and calcium (Table 4.4).

Table 4.4: Principal Component analysis showing the influence of soil parameters on the density of soil biota during summer season in Ranni area (after flood)

Variable	PC1	PC2	PC3
Temperature	0.20266	0.29405	0.26253
p^H	0.23169	0.15882	-0.21989
OC	-0.20763	-0.1852	-0.29238
EA	0.35845	0.09313	0.1045
EB	0.13469	0.22076	-0.17785
Sand	-0.16559	-0.05255	-0.41728
Silt	-0.1587	0.23345	0.35133
Clay	-0.34305	0.13834	0.13451
Moisture	0.13631	0.09841	-0.3896
N	0.1833	0.31493	-0.24005
P	-0.35511	0.05106	-0.13849
K	0.3375	0.1538	-0.12599
Ca	0.25175	-0.11367	0.32839
Mg	-0.15105	-0.38624	0.10115

KOZHENCHERY

BEFORE FLOOD

Principal component analysis revealed that the principal factors affecting density of Collembola, Isoptera, Coleoptera and Gastropoda during post monsoon season were temperature, p^H , EB, sand, silt, clay, moisture, Phosphorus, Potassium and Magnesium. Second principal factors influencing density of Diplopoda, Isopoda, Collembola, Hymenoptera and Coleoptera were temperature, EB, sand, silt, clay, Calcium and magnesium. (Table 4.5).

Table 4.5: Principal Component analysis showing the influence of soil parameters on the density of soil biota during post monsoon season in Kozhenchery area (Before flood)

Variable	PC1	PC2	PC3
Temperature	0.07537	0.23522	0.35393
p^H	0.18853	-0.30204	0.15559
OC	-0.20554	-0.0494	0.27483
EA	-0.2582	-0.2328	0.09795
EB	0.16265	0.19034	-0.22531
Sand	0.26526	0.21828	-0.03826
Silt	0.26934	0.17103	-0.17446
Clay	0.05949	0.36741	0.16431
Moisture	0.01609	-0.11185	0.31758
N	-0.27495	-0.00104	-0.1486
P	0.13098	-0.16794	-0.32121
K	0.25344	-0.11764	0.1829
Ca	-0.30552	0.05042	-0.00126
Mg	0.08424	0.33855	0.01005

Temperature, p^H , EA, sand, Nitrogen, Phosphorus, Calcium and Magnesium were observed to be the principal factors affecting the density of Acari, Diplopoda, Isopoda, Isoptera, Orthoptera, Coleoptera and Gastropoda on principal component analysis, in Kozhenchery area during post monsoon (Table 4.6).

Table 4.6: Principal Component analysis showing the influence of soil parameters on the density of soil biota during summer season in Kozhenchery area (Before flood)

Variable	PC1	PC2	PC3
Temperature	0.07747	0.32893	0.13521
p^H	0.2785	0.14181	0.18256
OC	0.01357	0.35506	-0.03144
EA	0.24784	0.25858	-0.01372
EB	-0.23174	0.12566	0.07647
Sand	0.19824	0.17356	-0.27113
Silt	-0.29871	-0.14048	0.01951
Clay	-0.18769	0.06479	-0.16986
Moisture	-0.05791	-0.10189	-0.36715
N	0.0897	0.09167	0.27925
P	0.04116	0.16667	0.28542
K	-0.14071	0.21227	-0.26729
Ca	0.02631	-0.32289	-0.19174
Mg	0.05244	-0.08953	0.29786

AFTER FLOOD

It could be observed that in Kozhenchery area during post monsoon season, the principal factors affecting density of Annelida, Collembola, Hymenoptera and Pauropoda were Temperature, p^H, EA, EB, OC, silt, clay, nitrogen, and magnesium. Second principal factors such as Calcium, temperature, EA, clay, phosphorus and magnesium influenced density of Acari, Annelida, Collembola, Hymenoptera, Isoptera, Coleoptera and Gastropoda. (Table 4.7).

Table 4.7: Principal Component analysis showing the influence of soil parameters on the density of soil biota during post monsoon season in Kozhenchery area (After flood)

Variable	PC1	PC2	PC3
Temperature	0.31441	0.03035	0.07979
p^H	0.26583	0.11268	-0.11818
OC	0.01848	-0.16991	-0.44292
EA	0.00014	0.43585	-0.04071
EB	0.16046	-0.28838	-0.18703
Sand	-0.19851	-0.37075	-0.07097
Silt	0.18211	0.34149	-0.2106
Clay	0.2238	0.29717	-0.23649
Moisture	-0.33968	-0.06295	-0.00115
N	0.13193	-0.08832	0.47639
P	-0.09499	0.35954	0.30361
K	-0.30922	-0.1201	0.22518
Ca	-0.28958	0.24507	0.11912
Mg	0.24867	0.14357	0.30314

During summer, the principal component analysis showed that temperature, OC, EA, moisture, Calcium and Magnesium were the principal factors affecting Isopoda, Annelida, Collembola, Hymenoptera and Isoptera. Second principal factors such as Temperature, p^H, EA, EB, OC, silt and Potassium influenced the density of Diplopoda, Annelida, Collembola and Isoptera. (Table 4.8).

Table 4.8: Principal Component analysis showing the influence of soil parameters on the density of soil biota during summer season in Kozhenchery area (After flood)

Variable	PC1	PC2	PC3
Temperature	0.28261	0.05032	0.2355
p^H	-0.17088	0.2532	0.35319
OC	0.20582	0.33925	-0.25536
EA	0.31145	0.08076	-0.04656
EB	-0.22693	-0.23778	-0.25296
Sand	-0.2748	-0.18063	0.02653
Silt	0.32067	0.11315	0.0397
Clay	-0.33952	-0.00813	0.04765
Moisture	0.26036	-0.28111	-0.02601
N	-0.19372	-0.33757	-0.10075
P	-0.33428	-0.08866	-0.01147
K	-0.09781	0.29884	-0.11024
Ca	0.23831	-0.35852	0.05364
Mg	0.21325	-0.19118	0.22202

CHENGANNUR

BEFORE FLOOD

PCA Analysis revealed that Temperature, p^H, sand, silt, moisture, Nitrogen, Calcium and potassium were the primary factors controlling the distribution of Acari, Diplopoda, Isopoda, Hymenoptera, Orthoptera, Coleoptera, Gastropoda and Pauropoda in Chengannur area during post monsoon season. Second principal factors affecting density of Acari, Diplopoda, isopoda, Annelida, Collembola, Hymenoptera and coleoptera were found to be temperature, EB, silt, clay, phosphorous, and Potassium. (Table4.9).

Table 4.9: Principal Component analysis showing the influence of soil parameters on the density of soil biota during post monsoon season in Chengannur area (Before flood)

Variable	PC1	PC2	PC3
Temperature	0.01332	0.31323	0.19944
p^H	0.04709	-0.27297	0.16389
OC	-0.08401	-0.05162	-0.48652
EA	-0.28067	-0.0916	-0.15378
EB	-0.23867	0.22577	0.12088
Sand	0.28821	-0.04965	-0.1785
Silt	0.24726	0.22671	0.02683
Clay	-0.238	0.10178	0.10221
Moisture	0.16868	-0.19753	0.31252
N	0.24834	-0.09063	-0.319
P	-0.14233	0.23406	-0.01974
K	0.21926	0.1082	-0.22811
Ca	0.02517	-0.25886	-0.34911
Mg	-0.28907	0.15018	-0.08863

On principal component analysis, it could be observed that temperature, EA, moisture, Nitrogen, Magnesium and potassium were the principal factors controlling the distribution of acari, coleoptera, gastropoda and pauropoda during summer season (Table 4.10).

Table 4.10: Principal Component analysis showing the influence of soil parameters on the density of soil biota during summer season in Chengannur area (Before flood)

Variable	PC1	PC2	PC3
Temperature	0.01926	0.1759	0.38092
p^H	-0.067	-0.08128	-0.06497
OC	-0.23693	0.24007	-0.09005
EA	0.11022	0.13756	0.37767
EB	-0.07795	-0.22091	0.2496
Sand	-0.07391	-0.22637	-0.29644
Silt	-0.27111	-0.12632	-0.02547
Clay	-0.01339	-0.23836	0.30643
Moisture	0.2705	-0.18897	-0.08535
N	0.31715	0.05983	0.05888
P	-0.29797	-0.05535	0.09786
K	0.24338	-0.14934	-0.20836
Ca	-0.10934	0.28848	0.09542
Mg	0.08042	0.34146	-0.03464

AFTER FLOOD

It could be observed that in Chengannur area during post monsoon season, the principal factors affecting density of Annelida, Collembola, Hymenoptera and Pauropoda were Temperature, p^H, EB, OC, sand, silt, clay, Potassium and magnesium. Second principal factors such as OC, EA, EB, sand, Calcium, phosphorus and magnesium influenced density of Acari, Annelida, Collembola, Hymenoptera, Isoptera, Coleoptera and Gastropoda. (Table 4.11).

Table 4.11: Principal Component analysis showing the influence of soil parameters on the density of soil biota during post monsoon season in Chengannur area (After flood)

Variable	PC1	PC2	PC3
Temperature	0.24835	0.09714	0.20422
p^H	0.06405	-0.30685	-0.21267
OC	0.12616	0.04699	0.47405
EA	-0.3683	0.08618	0.13574
EB	0.2021	0.12006	-0.34209
Sand	0.24155	0.33117	-0.09443
Silt	0.02445	-0.36568	-0.24265
Clay	0.33827	-0.20137	-0.07577
Moisture	-0.21034	0.15784	-0.32674
N	0.13326	-0.33215	0.27231
P	-0.20915	0.24	0.16504
K	0.33361	-0.06781	0.20814
Ca	-0.27561	0.27753	0.11046
Mg	0.22504	0.33435	-0.13663

Principal factors affecting the density of Annelida, Collembola and Isoptera were found to be moisture, temperature, exchangeable acid, silt, Potassium and Magnesium during summer. Second principal factors such as temperature, organic carbon and exchangeable base, slt, clay, Nitrogen and Phosphorus influenced Acari, Diplopoda, Isopoda, Annelida, Collembola and Hymenoptera while the density of Acari, Orthoptera, Coleoptera and Gastropoda were affected by moisture, temperature and pH. (Table 4.12).

Table 4.12: Principal Component analysis showing the influence of soil parameters on the density of soil biota during summer season in Chengannur area (After flood)

Variable	PC1	PC2	PC3
Temperature	0.19113	0.28289	0.13806
p^H	-0.06502	-0.22836	-0.52431
OC	0.33488	0.0197	0.00852
EA	0.32647	-0.07008	-0.15115
EB	-0.31797	0.06462	0.17811
Sand	-0.14362	-0.32697	0.00172
Silt	0.28768	0.13146	0.29712
Clay	-0.03176	0.36152	-0.2991
Moisture	0.05545	-0.34514	0.13911
N	-0.04018	0.38754	-0.01582
P	-0.24087	0.26511	-0.08796
K	0.33691	-0.08705	-0.05739
Ca	-0.22188	-0.27022	0.16665
Mg	0.26885	-0.11168	-0.34797

DISCUSSION

Soil is considered as a complex of living and non-living components. Life is vital to soil and soil is vital to life (Thompson and Troeh, 1979). Soil is the store house of plant nutrients and moisture. Soil characteristic as it determines the infiltration, water storage, tilling, aeration and soil fertility. Soils are one of the last great frontiers for biodiversity and home to an extraordinary range of microbial and animal groups. The soil micro arthropods exercise a decisive role in the perpetuation of the productivity of soils, through their activities in the breakdown and decomposition of litter and organic matter. Soil micro arthropods play very significant role in soil fertility. Microarthropods have great ecological significance, in the breakdown and decomposition of litter, nutrient cycling and the role in secondary production and energy flow.

Biological activities in soils drive many of the key ecosystem process that governs the global system, especially in the cycling of elements such as carbon, Nitrogen and phosphorus. Kurup, (1982) studied the physico-chemical characteristics of soil, soil moisture content, organic matter content, soil pH, rainfall and humidity. Climate, which is determined by temperature and rainfall, exerts a significant influence on the organic matter status of soil. Organic matter plays an important role in improving soil physical conditions. It improves infiltration movement and retention of soil reaction, soil temperature and soil strength and root penetration. Organic matter in soil is a dynamic material.

Flood affected areas of Pampa River basin from Ranni to Chengannur were studied. The study area covers 3 Taluks: a. Ranni Taluk b. Kozhencherry Taluk c. Chengannur Taluk. Sampling sites in Ranni taluk were Ayiroor, Ranni, Chettakkal, Cherkolpuzha and Perunad. Sampling sites in Kozhencherry taluk were Aranmula, neervilakkam, Koyipuram, Arattupuzha and Malakkara. Sampling sites in Chengannur taluk were Chenngannur municipality, Pandanad, Othera,Thiruvanmandur, Venmony and Aala Panchayath.

Soil physico-chemical parameters like temperature, pH, Organic carbon, moisture, Exchangeable acid, Exchangeable base, sand, silt, clay, Nitrogen, Phosphorus, Potassium, Calcium and Magnesium were analyzed. Five soil samples were collected from study sites during post monsoon and summer season. Mean value along with standard error was calculated, and then data were converted to seasonal data by taking November and December as post monsoon; January and February as summer. Two way ANOVA test was conducted to find out any significant variation in the edaphic and chemical factors in the study area, before flood and after flood.

From the soil physico-chemical parameter studies it was found that after flood all parameters becomes decreased from their normal level, that also affect the population density of soil biota. The soil factors are important in controlling the density, distribution and abundance of soil fauna in various habitats. In the present study before flood the study sites were highly nutrient rich in post monsoon and summer seasons. The results corroborates with the study of several workers in the field of soil ecology and biochemistry (Koop and Field, 1980; Kato, 1976; Hat chett, 1947).

Soil fauna include a large number of species that play a central role in many essential ecosystem processes. When a natural system is shifted by human activities for agricultural or forestry purposes, major changes occur in the soil environment and in the fauna populations and community. From this study it was found that before flood, population density of soil biota were very high during post monsoon season than summer. The highest population density during post- monsoon was due to low soil pH, optimum soil temperature and adequate soil moisture. Summer showed low population density of soil arthropods due to increased pH towards neutrality and low moisture content, and high soil temperature. The

post monsoon showers along with highest organic carbon content of soil following the monsoon weathering favours the density increase of soil biota's in post monsoon season. (Cloudsley-Thompson, 1977). After flood the population density of soil arthropods were decreased. From the population density studies of soil biota's the Two way ANOVA results showed that there is significant variation in the population density of soil arthropods between before and after flood situations.

Post-monsoon temperature of soil favours the reproduction and multiplication of soil micro arthropods (Sanal Kumar and Sujatha, 1996). In summer most of the soil animals show vertical migration. They go very deep into the soil to avoid extreme temperature rise of the top soil. This is the reason for the low population density of soil animal groups in summer.

Comparatively before flooding the soils showed more population density of most of these animal groups when compared to after flooding soil. This may be due to the undisturbances of the before flood soil. The population density of different groups showed drastic variations in the number among different groups but no significant difference among same groups at different sites as revealed by ANOVA tests.

The principal component analysis result showed that pH, organic carbon, moisture and temperature were the important factors controlling the distribution of soil arthropods of which pH is the primary factor. Most of the soil organisms did not tolerate a wide range of pH. A very low and very high pH in the soil adversely affects the density of soil micro arthropods. The low density of Orthoptera and Isoptera in soil was due to their adult life in air. The earlier studies also revealed that most of the soil micro arthropods are temperature-moisture-organic carbon dependent in most of the ecosystems for perpetuation (Warburg, 1968; Tsukamoto, 1977; Sunderland *et al*., 1976).

Among the edaphic factors all are more or less important as far as the survival of soil micro arthropods except sand and clay. Among chemical factors Calcium is least important along with Phosphorus. Nitrogen, Potassium and Magnesium were found to be primary soil chemical factors controlling the density and distribution of soil micro arthropods.

From the study it was revealed that the seasonal variations in soil edaphic and chemical factors influencing the population density of soil micro arthropods. Soil functioning is affected by the abundance and the diversity of soil organisms. Decreases of diversity due to human activities may induce a degradation of soils and some changes in functional processes. Soil properties maintain the ecosystem services; disturbances linked to natural forces and to human activities can alter physical, chemical and biological properties of soils, which can, in turn, impact on soil stability (Buger and Zedaker, 1993; Gupta and Malik, 1996).

RECOMMENDATIONS

- Mulch applied to the surface of soil. Different types of much applied like soil mulching, straw mulching and live mulching. Mulching insulates the soil helping to provide a buffer from heat and cold temperatures, retains water helping to keep the roots moist, keeps weeds out to help prevent root competition, prevents soil compaction and reduces lawn mower damage.
- Soil fertility can be further improved by incorporating cover crops that add organic matter to the soil, which leads to improved soil structure and promotes a healthy, fertile soil.
- Farmers should be given financial support for organic farming which only can improve the soil fertility gradually in the flood affected soil.
- Extensive study on the diversity and density of soil microarthropods and other mesofauna is necessary in the flood affected areas to a minimum of 3 years then only improvement of soil fertility and loss of soil fauna diversity can be assessed scientifically.
- Avoid the overuse of chemical fertilizers in the agro ecosystems to reduce over nutrition in the crop sowing season and gradual reduction of soil fertility in the subsequent seasons. Overuse of chemical fertilizers in the soil reduces the population density of soil micro arthropods.
- For restoring soil fertility the best method is to grow microorganisms. Encourage the growth of soil micro organisms and maintain the soil fertility through their decomposition process.
- Promote organic farming in the agro-systems of Kerala as far as possible with the technical and financial help of state agricultural department.

- Promote the use of vermicompost, cow dung and slurry in the field to improve the density of soil micro arthropods and thereby increasing soil fertility.
- Mulching the flood affected soil with *Gliricidia sepium* (spotted *Gliricidia*; Mal: Cheemakonna) is very effective to improve soil nitrogen content thereby improving microarthropod density.
- Promote the cultivation of nitrogen fixing plants like leguminous plants in the flood affected areas
- Promote the spreading of organic agro-forestry systems with multispecies culture in the home gardens to improve soil fertility and multilayer canopy. This may lead to diversity of crops and availability of multilevel nutrient composition in soil by the action of micro arthropods.
- Advocate the use of organic pesticides like neem decotions and tobacco decotions to reduce pest problems in the field thereby reducing chemical pesticide contamination in soil and strengthen the density of micro arthropod community.
- Mixed cropping improve soil fertility, to plant different crops in the same field in order to prevent soil erosion and control the spread of soil-borne plant disease.
- Organic based fertilizer use is beneficial because it supplies micronutrients, and organic components that increase soil moisture retention and reduce leaching of nutrients. Organic fertilizers can be used on acid tolerant and those better suited to neutral or alkaline conditions. It can improve the biodiversity and long-term productivity of soil, and may prove a large depository for excess carbon dioxide.

- Biofertilizers like microbial inoculants which are capable of mobilizing important nutritional elements in the soil from non-usable to usable form through biological processes.
- Control by law and awareness campaign is necessary to reduce man made pollution on soil.
- Consult with a professional agricultural officer once in 6 months after testing soil to discuss about the soil status and health.
- Since the flood destroyed soil condition very badly. Livelihood of farmers who are depending only on agriculture is highly hampered. So reasonable yield from this soil for about 2-3 years cannot be expected. Farmers should be supported with financial aid from Government agency or other NGOs.

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