A REPORT ON THE SOIL CHARACTERISTICS OF CENTRAL UNIVERSITY OF KERALA CAMPUS, PERIYE, KASARAGOD

By

Dr. PRATHEESH P (Assistant Professor AND HOD i/c)
Dr. SANDEEP K (Assistant Professor)
Dr. SIJINKUMAR V (Assistant Professor)
Dr. CHANDANKUMAR B (Assistant Professor)
AHAMED ARSHAK T (M.Sc. student)
REETHU MOHAN (Research Scholar)
ARAVIND G H (Research Scholar)
RESHMA K V (Research Scholar)

DEPARTMENT OF GEOLOGY
CENTRAL UNIVERSITY OF KERALA

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Chapter 1

INTRODUCTION

1.1 Soil and its classification

Soil is a complex and heterogenous system that serve as a medium for the growth of plants. Soil is defined as the weathered and unconsolidated material on top of the bed-rock that contains organic matter and is capable of supporting plant life (Carlson et al., 2008). Upper limit of soil act as a boundary between land and air. They are formed as a result of in situ weathering of parent rock or by the accumulation of mineral matter transported by agents such as water, wind, or ice. The parent rock from which the soil has formed may be near to that soil or it can be found at greater distance from the soil. The main components that are found in all types of soil are organic matter, minerals, water and air.

Formation of soil is affected by various factors. Physical, chemical or biological processes that take place in the soil as a result of time, parent material, climate, precipitation, topography and so on is called pedogenic processes. Different soil forming process occur an environment. The interaction of all soil forming factors under different environmental condition set a path to soil forming processes.

Soil is formed as a result of very long process. Pedogenesis is described as the process in which soil is formed. The soil formed by disintegration of parent material is later transported by wind, water, glaciers and so on. The parent material undergoes both physical and chemical weathering and this rate of weathering is also controlled by factor such as climate. Soil formation can be seen as a result of weathering, development of soil structure, distinction of structure into different horizons and also by transportation.

There are seven mechanism proposed for soil formation. (1) Accumulation of material- In the top layers of the soil profile organic materials or minerals are added to the soil by natural forces such as wind, water, glacier and so on. (2) Leaching and losses- It is process of removal of soluble components from the soil profile soil profile and these components are washed down to the bottom soil. (3) Transformation and illuviation- It is the chemical weathering of grains and organic materials into decay resistant matter. (4) Podsolisation and translocations- are found to occur when strong acid solution breaks down clay minerals as a result of which silica, aluminium and iron form complexes with organic substances in the soil. (5) Laterization- is a process in which laterite soils are formed. They are found to occur in tropical and sub-tropical environment. (6) Calcification- it occur when evapotranspiration exceeds precipitation. (7) Gleying- is a process in which iron compounds are reduced, removed or segregated as mottles or concretions in the soil. They occur in waterlogged or anaerobic conditions. (Balasubramanian, 2017).

1.2. Scope and objectives of the present study

The particle size distribution of the soil mineral fraction modulates physical, chemical, and biological properties, including soils hydraulic properties, pore size distribution, shrink and swell capacity, erodibility, and sedimentation, with implications for agro-ecological, mechanical, hydrological, geological, and engineering applications (Bieganowski et al., 2018; Blake and Steinhardt, 2008; Gee and Or, 2002; Hillel and Hatfield, 2005; Merkus, 2009). Soil texture is a chief fertility parameter since it influences the soil-water-retention capacity (Salter and Williams, 1965), organic matter contents (Plante et al., 2006), carbon and nutrient storages (Silver et al., 2000), and color (Rossel et al., 2006; Konen et al., 2003). Soil texture plays a major role in providing information on the soil grain size distribution and grain size fraction representation. The particle size is one of the main physical characteristics of soil/sediments which show us the changes in transport capacity and depositional environment. The present study aims to characterize the soils of the Central University of Kerala campus, Periye, Kasaragod district based on grain size distribution.

1.3. Location and Setting

The permanent campus of the Central University of Kerala spans an area of 310 acre at Tejasiwni Hills, Periye, Kasaragod, the northernmost district of Kerala state, India (Fig. 1.1). The area is occupied between the north latitudes of 12° 22′51.04” and 12° 23′53.14”, and East longitudes of 75°05’44.69” and 75°05’29.04”. Politically this area included in Periye Pullur Grama Panchayath.

1.4. Physiography

The Central University of Kerala is a part of Midland area of Kasaragod. The study area undulating topography with small hillocks and valleys. The altitude varies from 44 to100 meters above mean sea level. The coastal plain is about 8 km distance from the study area.

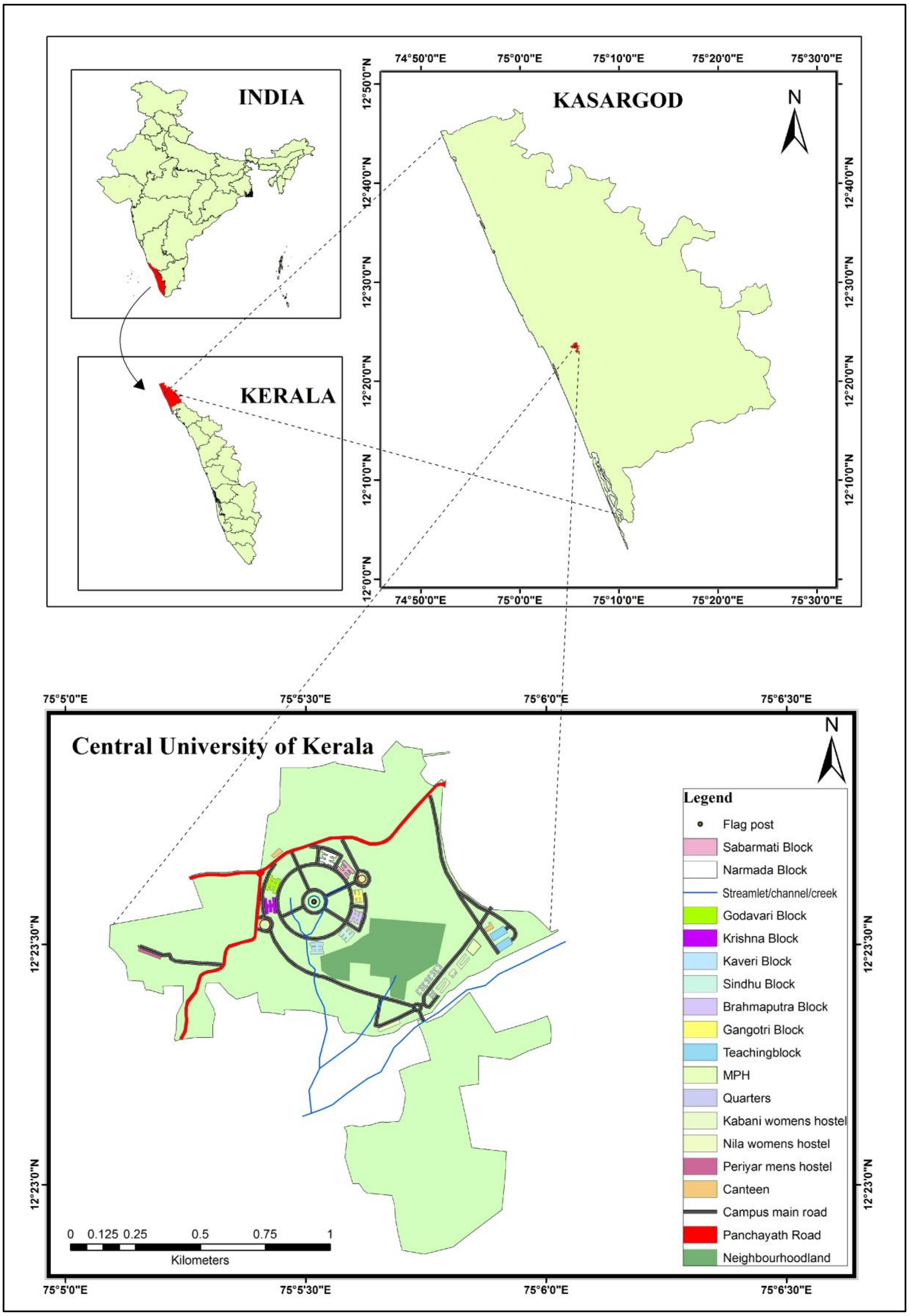

Fig 1.1. The location map of the study area (Central University of Kerala).

1.5. Geology and Hydrogeology

Kasaragod is a part of Precambrian metamorphic shield in which majority of the area is occupied by Archean rocks. Geologically the district can be divided into five belts: southern Charnockitic rocks, Northern Gneiss, Syenite pluton in central, isolated capping of sedimentary rocks (Warkalli Formation) confined to coastal tract, Quaternary sediments of the coastal plain (District Survey Report, 2016). These rocks are extensively lateritised in most part of the district. It covers all the underlying rock formation except Quaternary deposits. Generally it is 5 to 15-metre-thick, hard, ferruginous and bauxitic at places (District Survey Report, 2016).The laterite is the main aquifer of groundwater as well. The study area is also a lateritic terrain with thick sequence of laterite with no parent rock visible. Laterite in the area is ferruginous, porous and hard. Due to the porous nature the wells, laterite gets recharged fast and water escapes as subsurface flow.

1.6. Soil

The laterite is covered by lateritic soil, having thickness of 0.5 to 1 meters. The laterite is generally underlain the lithomarge clay and which is the preliminary laterization front.

1.7. Climate

The district including the study area receives an average of about 3500 mm rainfall annually. The major source of rainfall is southwest monsoon from June to September which is contributing nearly 85.3% of the total rainfall of the year. The north east monsoon contributes only 8.9% and remaining 5.8% is received during the month of January to May as pre monsoon showers. Out of the 106 rainy days in a year, 87 days occur during south west monsoon (CGWB, 2013).

The average mean monthly maximum temperature ranges from 29.2°C to 33.4°C and minimum temperature ranges from 19.7°C to 25°C (CGWB, 2013). The temperature is more during the months of March, April, May and less during December and January. Relative humidity is more during morning hours and less during evening hours. During the morning hours it ranges from 87.1% to 98.7% and during evening hours it ranges from 54.4% to 86.5%. The wind speed ranges from 2.1 to 3.3 km/hour. The wind speed is high during the months of March to June and less during the months of September to December. Sunshine ranges from 3.2 to 10.2 hours/day. Maximum sunshine is during the month of February. The months of June to August records the minimum sunshine due to cloudy sky. Good sunshine hours are recorded in the months of November to May.

Chapter 2

METERIALS AND METHODS

2.1 Sample collection

The soil samples (11 Nos.) were collected from an exposed soil profile within the campus during the pre-monsoon season of January to March 2020. The soil samples were collected in polythene bags/covers, labelled and transported to the laboratory. In the laboratory, the samples were air dried and further disaggregated using an agate mortar and pestle followed by sieving through ASTM sieve No. 10 (Mesh size 2 mm).

2.2 Pre-processing of samples

The quartering method was used here for size reduction of soil samples. Here the soil sample was distributed uniformly over a smooth area in layers so that it makes a flat pile that has a uniform diameter and thickness. This pile of sample is then divided into equal quarters. Two opposite quarter of samples are removed and are kept aside. The same procedure is done with the remaining portion of sample until the test sample of desired size is obtained.

About 10g of soil sample was taken in a pre-weighed glass beaker. The sample was then treated with 30 % hydrogen peroxide (H_2O_2) to remove the organic matter from the sample. The sample was then kept overnight for the completion of the reaction. Later it was thoroughly washed with water. This mixture was kept overnight and later excess hydrogen peroxide was removed from the mixture. It was dried in a hot air oven and weight loss was determined. The weight loss is calculated in percentages, which gives the organic matter content in the samples. A conversion factor of 1.724 has been used to convert organic matter to organic carbon based on the assumption that organic matter contains 58% organic C (i.e., g organic matter/1 .724 = g organic C) (Nelson and Sommers, 1996).

The soil sample was then treated with glacial acetic acid to eliminate carbonate material from the sample. The sample was then kept overnight for the completion of the reaction. The next day sample was washed with water to remove the excess acetic acid. It was dried in a hot air oven and weight loss was determined which gives the $CaCO_3$ content in samples.

Sodium hexametaphosphate (Calgon) was added to the sample to deflocculate the clay size particles. This procedure was carried out because clay possess negatively charged ions present in them which get attracted to positively charged ions in the solution which makes separation of clay particles difficult.

2.3 Particle size analysis

The particle size analysis was carried out by a series of standard procedures:

2.3.1 Wet sieving

Wet sieving was done to separate coarse grained material (+63 micron) from fine grained material (-63 micron). As the dispersing of clay particle is completed, the samples were wet sieved using 230 ASTM mesh with distilled water. Particles having size greater than 230 ASTM mesh size (silt + clay) will be collected in the mesh and particles having size lesser than 230 ASTM mesh (sand) will be collected in a glass beaker. The coarser particles in 230 ASTM mesh are transferred to a glass beaker and is left for oven drying. The finer particles collected in the glass beaker is transferred to 1000ml measuring cylinder for pipette analysis.

2.3.2 Pipette Analysis

The silt + clay solution was stirred thoroughly and transferred into a 1000 ml measuring cylinder. Solution was made up to 1000 ml using water. After making it up to 1000 ml volume, the silt and clay fraction was determined using pipette analysis (Carver, 1971). The column containing silt and clay was stirred vigorously using a long stirring rod. After 20 seconds of the stoppage of stirring, 20 ml of the liquid was pipetted out from 20 cm depth. Pipetted sample contain silt + clay fraction. Pipetted sample was then transferred to a small beaker and was oven dried. After 1 hour and 30 minutes of the stoppage of stirring, 20 ml of the liquid was pipetted out from 10 cm depth. Pipetted sample contain clay fraction. Pipetted sample was then transferred to a small beaker and was oven dried for weight calculation. The weight percentage of sand, silt and clay was calculated.

Chapter 3

TEXTURAL CHARACTERISTICS OF SOILS OF CENTRAL UNIVERSITY OF KERALA CAMPUS

3.1 Classification of soils

A wide variety of soils are found in Kasaragod District. The different types of soils formed in the district is due to the topo-lithosequence along with variation in rainfall, temperature and alternate wet and dry conditions. The soils of Kasaragod District can be broadly grouped into coastal alluvium, mixed alluvium, laterite, hill and forest soils (Department of Mining and Geology, 2016; Department of Soil Survey and Soil Conservation, 2021). An analysis of soil type map of Central University of Kerala campus (Fig. 3.1) shows that predominant soil type in the district is lateritic soil. According to USDA (United States Department of Agriculture) classification most of the soils in the study area belongs to Ultisols order (Kumar et al., 2020).

Laterites are acidic in nature and are coarser in texture. These soils lack fertility due to the lack of nitrogen, potassium, and organic elements. The origin, formation and distribution of laterite was proposed by several people (Foote, 1876; Medlicott and Blandford, 1879; Fermor, 1909), and a detailed documentation of its occurrences along the west coast are given by Fox (1923, 1936), and more recently by Bruckner and Bruhn (1992), and Widdowson and Gunnell (1999). High temperature and rainfall play a major role in the formation of laterite

Climate also play a major role in the formation of laterite. The conditions such as high rainfall, high humidity and high mean annual temperature are favourable for their formation. Tectonically stable region with minimum upliftment, deformation or erosion is also favourable (Widdowson, 2009). The high iron content present in the laterite is due to the depletion of mobile element during weathering. In weathering process water containing dissolved carbon dioxide is the reactant that break up the parent rock. The first chemical study of laterite was carried out by Mallet (1883) in which he said that laterite was ferruginous and/or aluminous. The dominance of Fe_2O_3 and Al_2O_3 and the decline of SiO_2 in laterites were found out by Bauer (1898). The varying contents of aluminium oxides and iron oxides in Indian laterites was found out by Warth and Warth (1903). Laterite is essentially a mixture of varying proportions of goethite, hematite, gibbsite, boehmite, limonite and kaolinite (Roy Chowdhury et al., 1965; Bland and Rolls, 1998; Schaetzl and Anderson, 2005).

Fig. 3.1. Lateritic soil profile of CUK campus.

The parent rock of the lateritic soils of the campus are charnockites. The different horizons like top soil, pebbly layer, mottled zone, pallid zone and saprolite are observed in the profile. The saprolites grade in to unweathered parent rocks which occur at great depths.

3.2. Textural classes of soil profiles

Soil texture is one of the most stable properties and a useful index of several other properties that determine the agricultural potential of soil. It affects the properties of soil including its water supplying power, rate of water infiltration, aeration, soil fertility, ease of tillage and susceptibility to erosion. Sandy soils are porous, have high infiltration rates, and retain little water, but clays have low infiltration rates, retain much water and may be poorly drained. Aeration is good in sandy soils but poor in clays. Roots penetrate sand more easily than clays. The fine and medium textural soils, such as the loam, clay loam, sandy clay loam, silt clay loam and sandy silt loams are generally more desirable because of their superior retention of nutrients and water (White, 1987)

In order to understand the textural classes, soil profile samples are plotted in ternary diagram of Shepard (1954). Shepard diagram is a method for graphing a three-component system summing to 100%. The components are the percentage of sand, silt and clay. It plots as a point inside or along the sides of the diagram. The same named apex is achieved by a sample made entirely of one of the components such as 100% sand. A sediment lacking of one of the components falls along the triangle's side opposite the apex. The rest are somewhere in the middle. Shepard (1954) divided a ternary diagram into ten groups to classify sediment samples and follows the ternary diagram norms. For example, Shepard's "clays" contains at least 75% clay sized particles. "Sandy silts" and "silty sands" contain no more than 20% clay sized particles and "sand-silt-clays" contain no more than 20% of each of the three components. The metadata for the data set used to generate the sediment distribution map describes the exact boundaries of each of the ten group. The widely used Shepard (1954) SSC (sand, silt and clay) scheme classifies a sample as 'sand' as long as it contains more than 75% sand size particles, regardless of the fact that it may contain up to 25% silt or a 25% mixture of the two (Blott and Pye,2012)

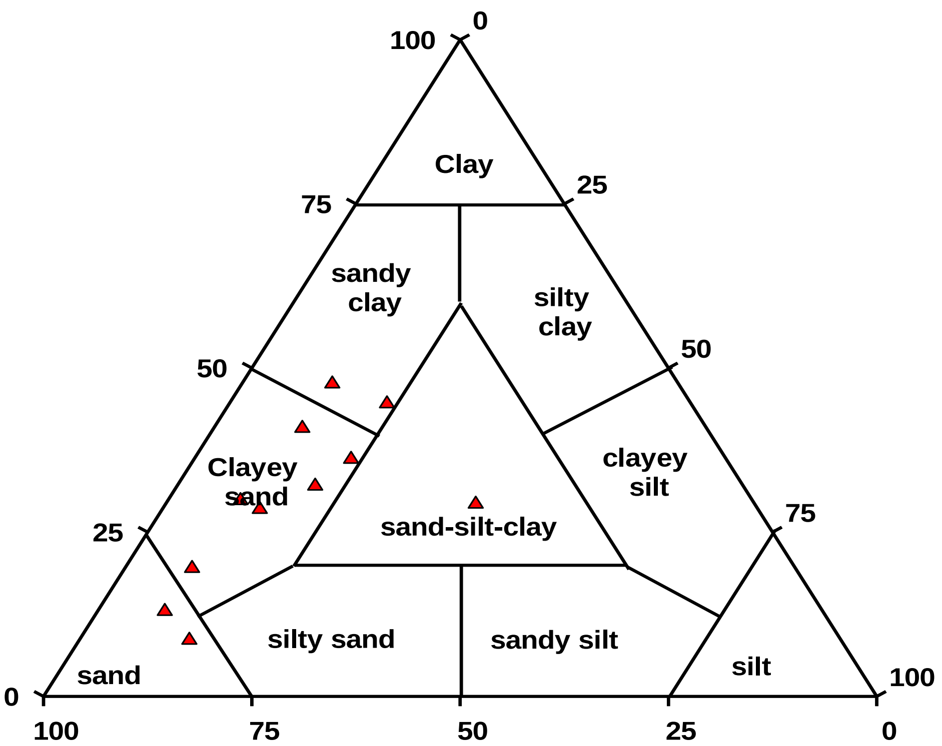

Fig. 3.2. Particle size distribution and classes of soil profile samples developed in CUK campus.

The sand content varies from 33.4 to.78.9 % (average =55.20%). The silt content and the clay content range from 8.09 to 37.23 % (average = 14.8%) and 8.5 % and 47.5 %

(average = 29.9 %) respectively. The organic carbon content varies from 0.46 to 4.43% (average=1.85%). The $CaCO_3$ content varies from 0.04 to 2.04% (average=0.79%).Sand percent in the soil profile (Fig 3.3) display increasing trend from 300 to 180 cm. After that shows a fluctuated distribution, first increasing up to 160cm, then decreasing up to 100 cm, again increase (60cm), then decrease and show an increased trend toward surface.

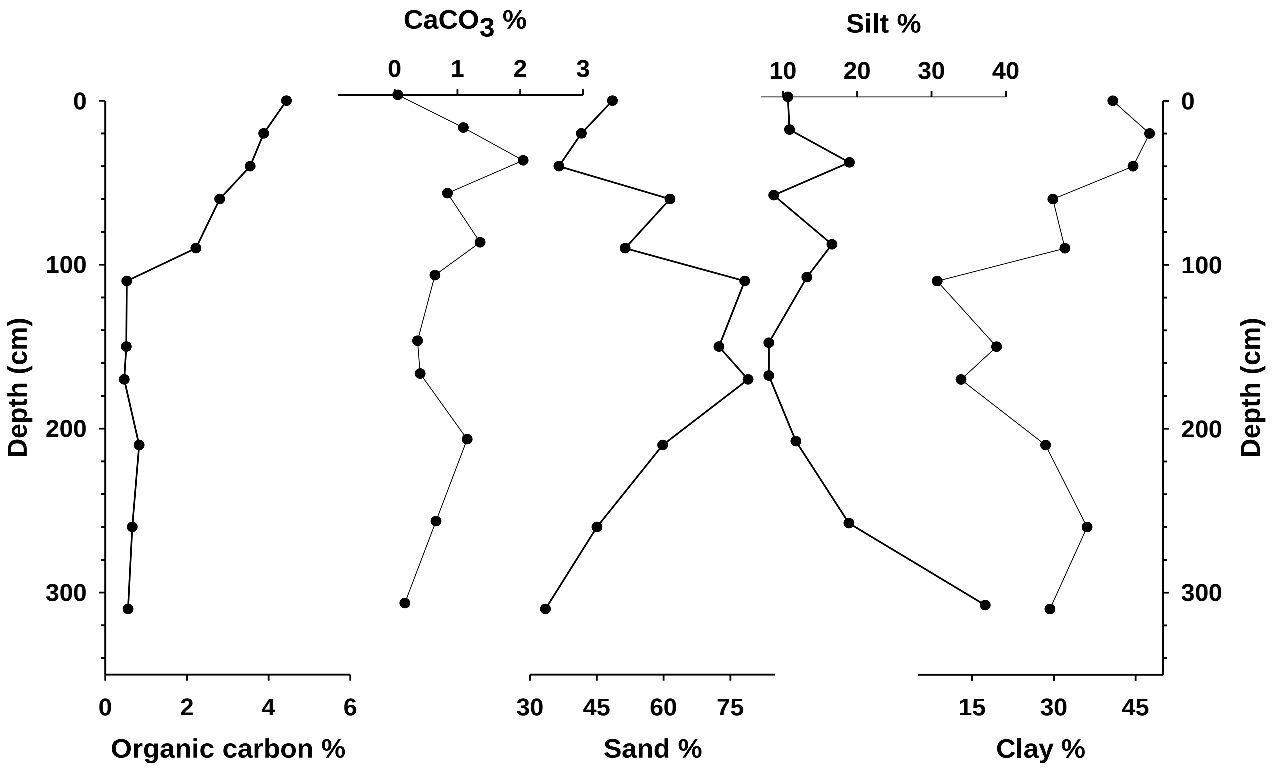

Fig. 3.3. The down-profile variations of organic carbon, $CaCO_3$, sand, silt and clay percentages in soil profile at CUK.

Percentage of silt distribution is higher in base than the top of soil profile. It exhibits a progressive decreasing trend from 300 to 160 cm, followed by increase up 100 cm. In the case of clay fraction, higher percent occurs in top layer than bottom. It also shows a decreasing trend from 300 to 180 cm and the graph shows a through at 100. Then shows increasing trend toward surface. Organic carbon content more in surface than bottom of the soil profile. It shows a steady growth from 300 to 100 cm and followed by increase trend up to top of the soil. Calcium carbonate shows increase trend from 300 to 200 cm. There is decreasing trend toward the surface.

CHAPTER 4

INVESTIGATIONS ON THE PRESENCE OF SOIL PIPING IN AND AROUND CENTRAL UNIVERSITY OF KERALA CAMPUS

4.1. Introduction

The “Soil piping” (tunnel erosion) is the sub-surface erosion of soil by percolating waters to produce pipe-like conduits below ground especially in non-lithified earth materials. Soil piping or “tunnel erosion” is the formation of subsurface tunnels due to subsurface soil erosion. Piping is an insidious and enigmatic process involving the hydraulic removal of subsurface soil causing the formation of an underground passage (Ingles, 1968). During rain, percolating waters carries finer silt and clay particles and forms passage ways. The resulting "pipes" are commonly a few millimeters to a few centimeters in size, but can grow to a meter or more in diameter. They may lie very close to the ground surface or extend several meters below ground. Once initiated they become cumulative with time, the conduits expand due to subsurface erosion leading to roof collapse and subsidence features on surface.

During the last decade many piping incidences were reported from different places in Kerala. Soil piping incidences were reported from many places in Kasaragod, Kannur, Kozhikode Wayanad, Malappuram, Kozhikode, Ernakulam, Idukki and Pathanamthitta. Except Thiruvananthapuram, Kollam and Alapuzha most of the districts in Kerala have the incidence of soil piping.

As compared to other districts, Kasargod is in front for soil piping and as well as soil pipe collapse which is followed by Kannur, Malappuram etc (Sankar et al., 2018)

. Laterite Mesas or midland elevated topography caped by hard duri crusts are much more common in Kasaragod district. In Kasaragod, soil pipe prone areas include the following (Sankar et al., 2018)

- Kumbala Ananthapura Temple
- Pallikkara
- Bethurpara
- Mali cave (Poovadukka)
- Nelliyadukkam

- Kizhakkanodi
- Possadigumpe
- Mundyathaduka (Perla Panchayath)
- Kuttikkol
- Adukkam (Mundal Temple)

4.2. Classification of Soil piping

In nature, soil pipes are formed by the process of subsurface erosion; these kinds of pipes are stable or unstable, which depend upon, geomorphology, soil type, hydrogeology etc. Most of them often goes unnoticed because of the subsurface process. Different types of pipes are observed in the high lands and each pipes have its own characteristics. The classification is mainly based on the size of common soil pipes observed in the State. Many places it is like underground drainage network like dendritic network. Based on the size, pipes are classified in to four stages of formation.

4.2.1. Micro pipes (Juvenile pipes)

Micro pipes or juvenile pipe are the initial stage of piping. The diameter of pipe is < 5cm. Clayey and lateritic soils are favorable for the formation of juvenile pipes. Juvenile pipes often found in the laterite cutting made for railways and roads. These pipes are responsible for saturating the soil causing toppling. The juvenile pipes when present in large numbers in an area, indicates the susceptible nature of the soil to piping (Sankar et al., 2018)

4.2.2. Small pipes (Younger pipe)

Small pipes are the second stage of development of the soil pipe. The diameter of pipe ranges from 5cm -30cm. It may combine together or individually developed as the formation of small pipe. Often road cuttings topple in the lateritic area after being saturated during monsoon rains. The presence of these pipes indicates that the terrain is very susceptible to piping (Sankar et al., 2018)

4.2.3. Typical pipes (Mature pipe)

Mature pipe is the third stage of development of pipe. The diameter of pipe ranges from 30cm to 5m. It may have an outlet and acts as an underground drainage. This is the common pipes seen in the Western Ghats. The land subsidence is often caused by the growth of these pipes. This often branches in to smaller pipes giving an appearance of dendritic pattern. The size of the tunnel reduces towards the outlet attaining an overall shape of a funnel. The outlet of these pipes is often located in the lower side slopes or the valley. Here the water comes out as a fountain rather than a spring (Sankar et al., 2018)

4.2.4. Oversized pipes (Huge pipe)

It is next stage of pipe after development of a typical pipe. The diameter of huge pipe is > 5m. It will also have an outlet. It acts as an underground drainage, it has no definite shape. These pipes often associate with their lower versions such as typical / mature pipes. These pipes are almost stable, the water erosion is very less and the walls of pipes are so hard (Sankar et al., 2018)

Soil piping is a natural process, but often human induce actions may result in change in surface and underground water flow and result in increased subsurface erosion and making soil pipe a potential risk. Soil pipe collapse may become a threat to farming and can threaten the stability of a building (Fig. 4.1).

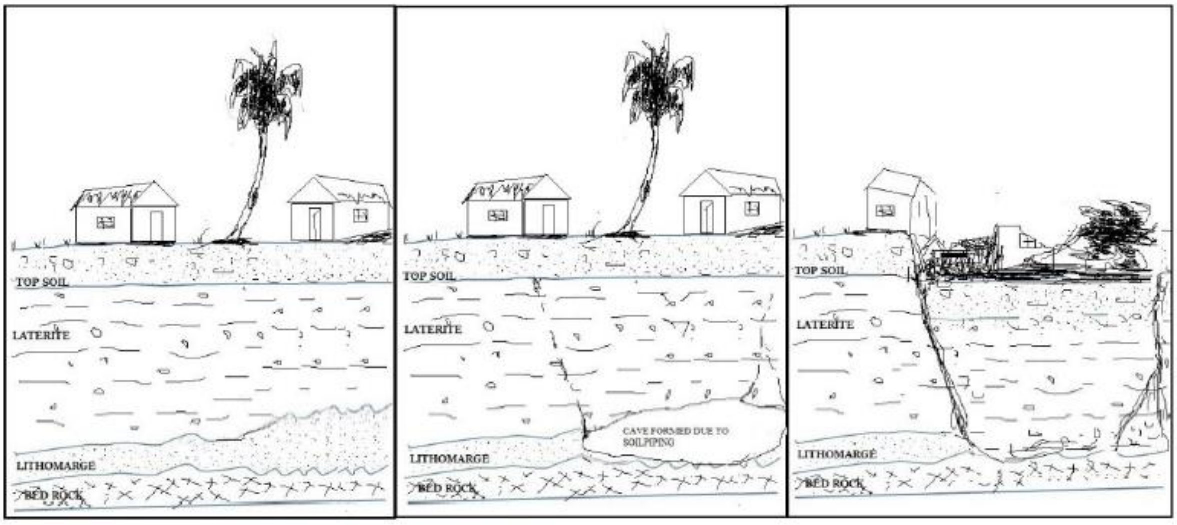

Fig. 4.1. Caving and after effects (Sankar et al., 2018).

4.3. Soil piping investigations in CUK campus

The central university of Kerala campus consists mainly of hard laterites. Duri-crust is observed on the top as capping in most parts. The area is situated in between Chandragiri river basin and Chithari river basin. The thickness of the duri crust is comparatively high near to the main campus. The soil piping is documented at many places in the campus. The lateritic blocks or terrain in the area indicates juvenile piping here. The wells in the south campus indicate the presence of extended trench like structure. Inside the wells, tunnels are beginning to form and getting joined to the well.

There are a total of 15 open wells, 7 bore wells and 3 ponds in and around CUK campus which are studied in detail and also newly constructed 3 wells and one unused dry open wells within the campus also observed. The wells and ponds that where very nearest to the boundary also included for observation Most of the open wells have dried recently. The details of the well location, water level, water quality and significant features observed in the well site are given in Table 4.1. The sites affected by soil pipings in the campus area are mapped which is displayed in Fig. 4.2. The depth of the water level in the wells varies from ~5 to ~17 m, depending on the terrain configuration. Most of the wells show cracking in walls of the well, high rate of sedimentation and presence of cave like structures or tunnels inside the well (Figs. 4.3, 4.4 and 4.5). Most of cavings aligned in E-W direction contains the turbid water. However the degree of turbidity varies in all these wells. This is also an indication that soil pipings are interconnected. The turbidity is because of the erosion and dispersion of lithomargic clay.

The three new wells oriented parallel to the stream (outside of campus) which have water level of 7-9 m. The sedimentation rate is very high in these 3 wells. The south campus area which is devoid of any buildings at present is composed of hard duricrust. But there is an exposed cave like structure. This trench has a depth of 4-5 m, length of 3-4 m, and width of 1-2 m (Fig. 4.6). Extended cave like structure is present inside the trench. The pipings are also present in the main campus, especially in the laterite quarries. The cave is of mature type and the diameter of entrance is around 5m and the extension of it is around 17-20m. The pipe is partially filled with subsided earth or lateritic material. The tunnel orientation is NW 260°. The pond constructed pond by Block Panchayath also exhibits huge deposits of sediments, cracks, caving and land subsidence. The trend of caving is around SW240° and cracks are extending towards upper surface.

There is high probability for the ground subsidence in these areas which may cause serious problems for the future construction projects. The soil piping may leads to formation of large cracks on surface. It is mainly caused by the subsurface erosion by underground water. The excess draining of water from the clay layer lead to subsurface erosion.

Table 4.1. The details of the wells, their water levels and significant features observed in CUK campus.

Well No.	Location	Water Level (m)	Total Depth (m)	Features	Rock Type	Quality of Water
1	N 12.39143° E 75.09995°	7.10	7.30	Cracks Starting from 2.5m to Downwards	Laterite	Moderate Turbulent
1a	N 12.39125° E 75.10007°	65	130		Laterite Charnockite	
2	N 12.39072° E 75.09958°	7.8	8.1	Caving Present below the water level, Deposition sediments	Laterite	Turbulent Water
2a	Borewell in well No. 1	30	55			
3	N 12.39069° E 75.09872°	5.53	5.75	Sedimentation Present No cracks visibe	Laterite	Clear
4	N 12.38985° E 75.09845°	11.57	13.3	No cracks visible upto waterlevel	Laterite	Clear
4a	N 12.38987° E 75.09865°	35	78.5			
5	N 12.38972° E 75.09671°	4.62	6.5	Cracks extending towards bottom	Laterite	Clear
6	N 12.38961° E 75.09653°	4.99	6.44	Caving starts from 3.5 m, Land once subsided Within the Well	Laterite	Moderately Clear
7	N 12.38865° E 75.09496°	11.1	11.9	Large Cracks in Upper Laterites extending towards bottom	Laterite	Clear
8	N 12.38781° E 75.09574°	11.92	12.1	Huge opening present which seems to be extending inside 2-3m,may be piping outlet, Huge deposition of sediments	Laterite	Turbulent Water
9	N 12.38618° E 75.09480°	13.02	14.2	No Cracks	Laterite	Clear

This will lead to subsidence due to its own weight. These ground subsidence will cause cracks in the hard lateritic cap rock or duricrust. The soil erosion in the bottom may or may not be active at the bottom. The land subsidence in wells maybe taken as indicator of active soil erosion in the subsurface. Further detailed studies are required to document the extent, cause, rate of erosion etc. which is necessary for the proper land management in these areas.

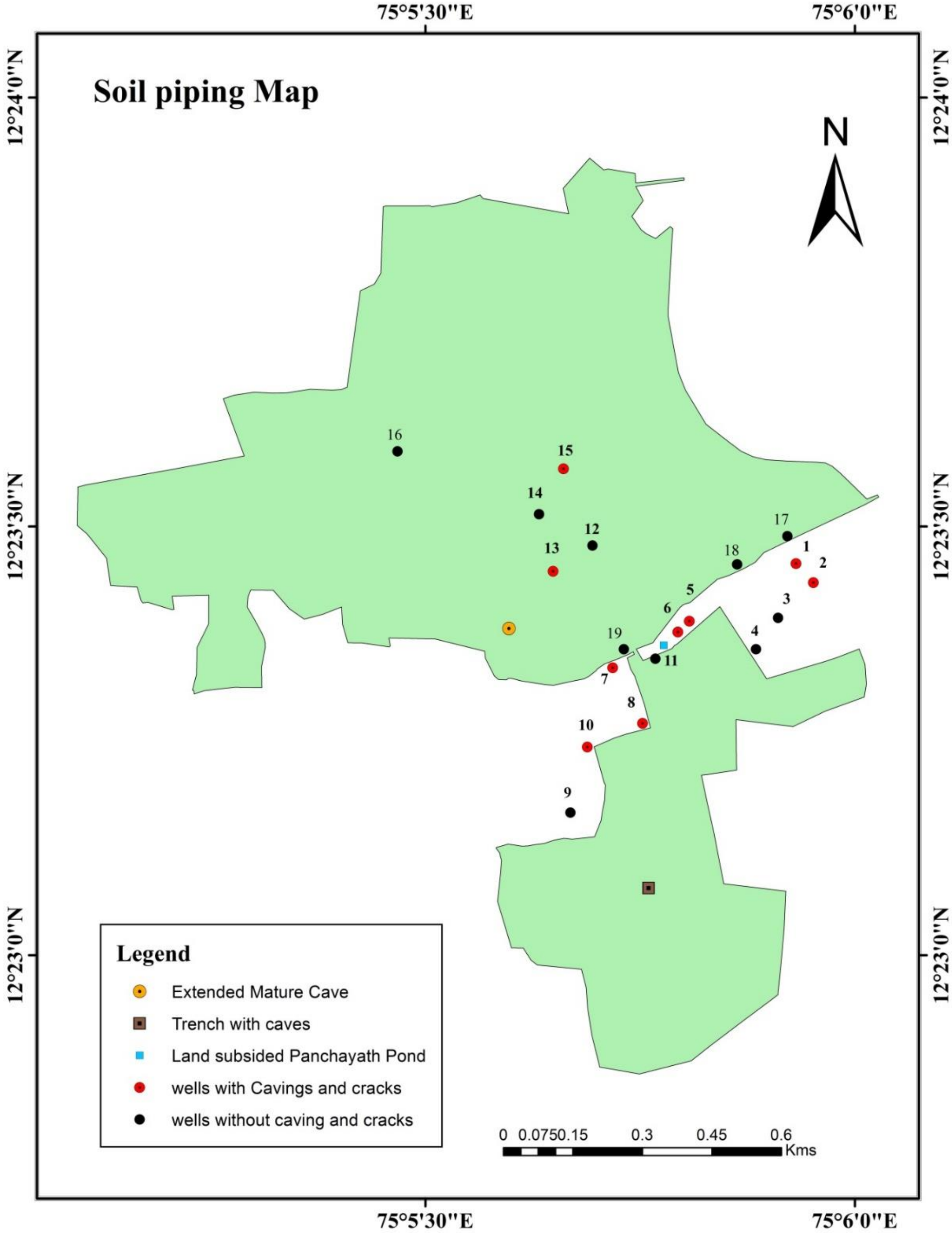

Fig. 4.2. Map showing locations of soil pipings in CU Kerala campus.

Fig. 4.3. Well No. 1 showing cracks and moderate turbulent water.

Fig. 4.4. Well No. 5 with cracks and clear water.

Fig. 4.5. Well No 8 with huge opening or caving at the bottom.

Fig. 4.6. The large laterite cavings in south campus, CUK

Chapter 5

CONCLUSIONS

The present study was carried out to characterize the subsurface soils of five soil profiles developed over different parent rocks in Kasaragod district. The grain size measurement of forty-six subsurface soil samples was carried out by sieving and pipette analysis. The textural characteristics were used to assess the degree of pedogenesis and the influence of parent rocks on the grain size characteristics of soil profiles. The conclusions derived from the present study are as follows:

- The lateritic soils predominantly belong to the category of sandy clay, sand-silt-clay, clayey sand, sand-silt-clay and clayey sand respectively.
- The particle size fractions (sand, silt and clay), organic carbon and calcium carbonate content exhibit significant variations along the profile.
- The higher proportion of clay is observed in the bottom portion of profiles probably because of illuviation process. The sand percentage in general increases towards surface of the soil profile. The silt content does not show significant difference between top and bottom of the soil profile. The calcium carbonate content decrease toward the surface. The organic carbon content increases towards profile top.
- The degree of pedogenesis in the profile is relatively less as compared to other soils developed on other types of parent rock as evidenced by relatively less clay content.
- Most part of the study area is prone to soil piping or tunnel erosion. However, more detailed studies are required to understand the extent, cause, rate of erosion etc. which is necessary for the proper land management.

REFERENCES

Balasubhramanian, A. (2017). Soil Forming Processes. 10.13140/RG.2.2.34636.00644.

Bauer, M. (1898). Contribution to the Geology of the Soychelles, especially to the knowledge of Laterite (translation by the Commonwealth Bureau of the Soil Science, Harpenden, Hertfordshire) Neves Jahrbech Mineralogie Geologie und Paleontologie. v. 2, pp. 163.

Bieganowski, A., Ryżak, M., Sochan, A., Barna, G., Hernádi, H., Beczek, M. & Makó, A. (2018). Laser diffractometry in the measurements of soil and sediment particle size distribution. Advances in agronomy, v. 151, pp. 215-279.

Blake, G. R., Steinhardt, G. C., Pombal, X. P., Muñoz, J. C. N., Cortizas, A. M., Arnold, R. W. & Stępniewski, W. (2008). Podzols. Encyclopedia of Soil Science, ed W. Chesworth (Dordrecht: Springer), pp. 580-582.

Bland, W. & Rolls, D. (1998). Weathering: An introduction to the scientific principles. Arnold, London.

Blott, S. J., & Pye, K. (2012). Partical size scales and classification of sediment types based on particle size distribution: Review and recommended procedures. Sedimentology, v. 59(7), pp. 2071-2096.

Brückner, H. & Bruhn, N. (1992). Aspects of weathering and peneplanation in southern India. Zeitschrift für Geomorphologie. Supplementband, v. 91, pp. 43-66.

Carver, R. E. (1971). Procedures in sedimentary petrology. URI: http://hdl.handle.net/1969.3/21450

Central Ground Water Board (CGWB) (2013) Groundwater information Nanded district Maharashtra. Ministry of Water Resources, Govt. of India.

Chowdhury, M. R., Venkatesh, V., Anandalwar, M. A., & Paul, D. K. (1965). Recent concepts on the origin of Indian laterite. Geological Survey of India, v. 31, pp. 547-558.

Department of Mining and Geology., (2016). District Survey Report of Minor Minerals (except river sand): Kasaragod District. Government of Kerala.

Fermor, L.L. (1909). The manganese-ore deposits of India (Vol.1). Government of India.

Foote, R. B. (1876). The Geological features of the South Mahratta Country and adjacent districts. Memoirs of Geological Survey of India. v.16, pp. 236-252.

Fox, C. S. (1923). Bauxite and aluminous Laterite occurrences in India. Memoirs of the Geological Survey of India. v. 49, pp. 1-287.

Fox, C. S. (1936). Buchanan’s laterite of Malabar and Canara. Record of Geological Survey of India. Part. 4, pp. 389-422.

Gee, G. W., & Or, D. (2002). 2.4 Particle-size analysis. Methods of soil analysis: Part 4 physical methods, v. 5, pp. 255-293.

Geological and Mineral Map of Kerala, (1995). Compiled by Mallikarjuna, C., Nair, M.M., Gopalakrishnan, L.S., Adiga, K.S., Nambiar, A.R., Balakrishnan,P.and Sukumaran, P. Geological Survey of India, scale 1: 500000, 1 sheet.

Hillel, D., & Hatfield, J. L. (Eds.). (2005). Encyclopedia of Soils in the Environment (Vol. 3). Amsterdam: Elsevier.

Konen. M. E., Burras. C. L., Sandor. J. A. (2003). Organic Carbon, Texture, and Quantitative Color Measurement Relationships for Cultivated Soils in North Central lowa. Soil Science Society of America Journal. v. 67(6). pp. 1823-1830.

Kumar K.S.A., Lalitha, M., Shivanand, K., Sujatha, K., Nair, K.M., Hegde, R., Singh, S.K. & Mishra, B.B. (2020). Major Soil Types and Classification. In: Mishra B. (eds) The Soils of India. World Soils Book Series. Springer, Cham.

Mallet, F. R. (1883). On laterite and other manganese ore occurring at Gosalpur, Jabalpur District. Records of the Geological Survey of India, v. 16, pp. 103-118.

Medlicott, H. B., & Blandford, W. T. (1879). Geology of India. Pt, 1, 379.

Merkus, H. G. (2009). Partical size measurements, size distribution and shape. Particle size measurments, Springer (Dordrecht). pp. 13-42.

Nelson, D. W., & Sommers, L. E. (1996). Total carbon, organic carbon, and organic matter. Methods of soil analysis: Part 3 Chemical methods, v. 5, pp. 961-1010.

Plante, A. F., Conant, R. T., Stewart, C. E., Paustian, K. & Six, J. (2006). Impact of Soil Texture on the Distribution of Soil Organic Matter in Physical and Chemical Fractions. Soil Science Society of America Journal. v. 70(1). pp. 287-296.

Rossel, R. A. V., Walvoort. D. J. J., McBratney. A. B., Jenik, L. J., Skjemstad. J. O. (2006). Visible, near Infrared, Mid Infrared or Combined diffusive reflectance Spectroscopy for simultaneous assessment of various soil properties. Geoderma, v. 131(1-2), pp. 59-75.

Salter, P. J., & Williams, J. B. (1965). The influence of texture on the moisture characteristics of soils: II. Available-water capacity and moisture release characteristics. Journal of Soil Science, v. 16(2), pp. 310-317.

Sankar, G., Varma, A. K., Sekha, L. & Kuriakose. (2018). Soil piping in the highlands and foothills of Kerala to avoid disaster, National Disaster Management Authority New Delhi by National Centre for Earth Science Studies Ministry of Earth Sciences, Govt. of India, pp. 204.

Shepard, F. P. (1954). Nomenclature based on sand-silt clay ratios. Journal of Sedimentary Petrology. v. 24, pp. 151-158.

Silver, W. L., Ostertag, R., & Lugo, A. E. (2000). The potential for carbon sequential through reforestation of abandoned tropical agricultural and pasture lands. Restoration Ecology, v. 8(4), pp. 394-407.

Soil Survey Organisation (2007). Benchmark soils of Kerala. Thiruvananthapuram, pp. 623.

Warth, H., & Warth, F. J. (1903). III.-The Composition of Indian Laterite. Geological Magazine, v. 10(4), pp. 154-159.

White, R. E. (1987). Introduction to the principles and practice of soil science. 2nd Edition. Blackwell Scientific, Oxford. UK.

Widdowson, M. (2009). Evolution of laterite in Goa. Natural Resources of Goa: A geological perspective, pp. 35-68.

Widdowson, M. & Gunnell, Y. (1999). Tertiary palaeosurfaces and lateritization of the coastal lowlands of Western Peninsula India. Palaeoweathering, Palaeosurfaces and Related Continental Deposits. International Association of Sedimentologists, Blackwell Science Ltd, Special Publications, v. 27, pp. 245-274.