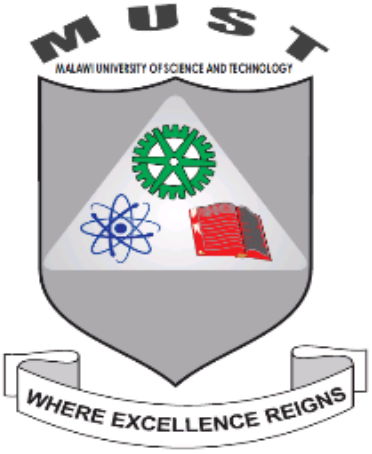



# EFFECTS OF SOIL TEXTURAL COMPOSITION ON INFILTRATION RATES

**PETER CHIMZIMU**

Dissertation submitted to Ndata School of Climate and Earth Sciences of the Malawi University of Science and Technology in partial fulfillment of the requirements for the Bachelor of Science degree in Earth Sciences.

19 July, 2021

**DECLARATION**

I Peter Chimzimu declare that this research project represents my own work and that it has never been submitted to this institution or any other institution for any academic purpose. All sources of information have been appropriately acknowledged.

Signature: 

Date 19 July 2021

**DISSERTATION APPROVED BY:**

SUPERVISOR:

DR CHISENGA Signature:

_____

ASSESSOR:

Title, Initials, Name Signature:

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**List of Figures**

Figure 1 Study area map ..... 3
Figure 2 Flow Chart ..... 8
Figure 3 Sampling points ..... 9
Figure 4 Infiltration double rings ..... 12
Figure 5 Infiltration rate test procedure ..... 13
Figure 6 Soil triangle ..... 15
Figure 7 Basic infiltration rate curve ..... 16
Figure 8 sand percentage map (0-30cm) ..... 18
Figure 9 sand percentage map (30-100cm) ..... 19
Figure 10 infiltration rate difference between PE 1and PE 10 ..... 20
Figure 11 infiltration rate difference between PE 4B and PE 11 ..... 21
Figure 12 infiltration rate difference between PE 7 and PE 15 ..... 22
Figure 14 cracked expansive soil ..... 23

**List of Tables**

Table 1 Soil sieve results..... 18

**Abbreviations**

Cl …… clay

Lat…….. latitude

Long…….. Longitude

Si……..... silt

Sa…….sand

**ABSTRACT**

Soil has many properties that are either chemical or physical properties. Examples of physical properties include soil texture, infiltration rate, and bulk density to mention just a few. Soil texture (percent fraction of sand, silt and clay), however, is believed to affect the rate of infiltration amongst other infiltration rate affecting factors. A better understanding would provide essential information in agricultural activities. This paper aims at understanding how soil texture affects the rate of infiltration. The infiltration of water in unused land was measured using double ring infiltrometer method. The relationships between infiltration and soil textural composition were analyzed. It was found that water infiltrates faster in sand soils than in loam and clay soils. It was also noted that infiltration rates were higher during onset of infiltration rate test and slowly decreases until saturation point is reached. It is then concluded that infiltration rate of water is affected by soil texture and rate of infiltration is higher in sandy than in loamy soils. The rate of infiltration decreases with soil depth in undisturbed land.

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**Contents**


1.1. Background ..... 1

1.2. Problem statement ..... 1

1.3. Objectives ..... 2

1.4. Research question ..... 2

1.5. Research Hypothesis ..... 2

1.6. Significance of study ..... 2

2.1. Study Area ..... 3

2.2. Soil ..... 4

2.3. Soil texture, sampling and sieving ..... 4

2.4. Infiltration rate and how soil texture affect infiltration rate ..... 6

3.1. Research design ..... 8

3.2. Data Collection ..... 9

3.2.1. Sampling Points ..... 9

3.2.2. Materials ..... 9

3.2.3. Soil sample collection ..... 10

3.2.4. Infiltration rate test ..... 11

3.3. Data analysis ..... 13

3.3.1. Soil sample analysis ..... 13

3.3.2. Soil Infiltration rate ..... 15

4.1. Soil texture from sieving ..... 17

4.2. Infiltration rate curves ..... 19

# 1. CHAPTER ONE: INTRODUCTION

## 1.1. Background

Soil is a valuable nonrenewable natural resource, which provides essential support to ecosystems throughout the world (Luca, 2018). All soils contain mineral particles, organic matter, water and air. The combination of these determines the soils properties. There are many properties of soil some of them are soil texture, soil PH, cation exchange capacity, infiltration rate, bulk density, porosity, consistence, color etc. Soil is made up of different sized particles. The sizes of these soil particles determine soil texture. Soil texture is the term used to indicate the relative content of particles of various sizes, such as sand silt and clay in the soil (Weil & Brady, 2007). Soil texture influences the ease with which soil can be worked, amount of water and air it can hold and the rate of infiltration. Soil texture affects other soil properties. For example, soil texture affects soil infiltration rate. Soil texture can influence whether soils are free draining, whether they hold water and how easy it is for plant roots to grow. Soil infiltration refers to the ability of the soil to allow water to move into and through the soil profile (Ralws, Brakensiek, & Saxton, 2014). In other way round, it is a measure of how fast water enters the soil, typically expressed in inches per hour (velocity or speed at which water enters the soil), for example 15mm/hour means that a water layer of 15mm on the soil surface will take one hour to infiltrate. Infiltration allows the soil to temporarily store water, making it available for use by plants and soil organisms. Infiltration rate affects many decisions concerning soil use. For example, high infiltration rate can lead to leaching of nitrate, nitrogen or pesticides and loss of phosphorus from soils that have a high level of phosphorus and hence this can affect agricultural activities. It is therefore important to understand how soil textural composition affect water infiltration rate.

## 1.2. Problem statement

Agricultural activities in many Southern region areas of Malawi (for example Phalombe) are mainly affected by soil conditions (Chirwa & Matita, 2012). Some of the soil characteristics that affect agricultural activities in these areas are water holding capacity of soil and how ease water soaks into the soil which is infiltration rate. However, different soil types in Phalombe district have different soil properties which in turn also lead to different infiltration rates. Understanding the relationship

between soil properties like soil texture to infiltration rate of an area is lacking however as no literat

## 1.3. Objectives

The main objective

1. To understand how soil textures affect infiltration rate.

Specific objectives

1. Determining the physical soil properties of Phalombe district based on sampled areas.

2. Calculating infiltration rate using double rings.

3. Evaluate the effect of soil infiltration on agricultural activities.

## 1.4. Research question

1. What are the soil properties of an area based on sampled points?
2. How can infiltration rate test be conducted using double rings?
3. Can soil infiltration rate affect agricultural activities?

## 1.5. Research Hypothesis

It is hypothesized that, increase in sand content increases the rate of infiltration keeping other factors that affect infiltration rate constant (Haghnazari & Shahgholi, 2015).

## 1.6. Significance of study

The results from this study will clearly indicate the relationship of soil textural composition on soil infiltration rate. This however, will help to consider soil textural composition of soil to any decisions that concerns soil infiltration rate. These include efficiency of irrigation and drainage, optimizing the availability of water for plants, improving the yield of crops and minimizing erosion. Likewise, adequate knowledge of soil infiltration data is essential for reliable prediction and control of soil and water related environmental hazards.

# 2. CHAPTER TWO: LITERATURE REVIEW

This chapter reviews in details soil, soil texture, soil sampling, sieving, infiltration rate

and effects of soil texture on infiltration rate. The study was conducted in Phalombe district.

## 2.1. Study Area

The study was conducted in Phalombe district (coordinates of -15.7633300 lat and 35.6587500 long) which is located in southern Malawi (Figure 1). Phalombe has average rainfall of 1908mm and average terrain of 759 m above sea level.

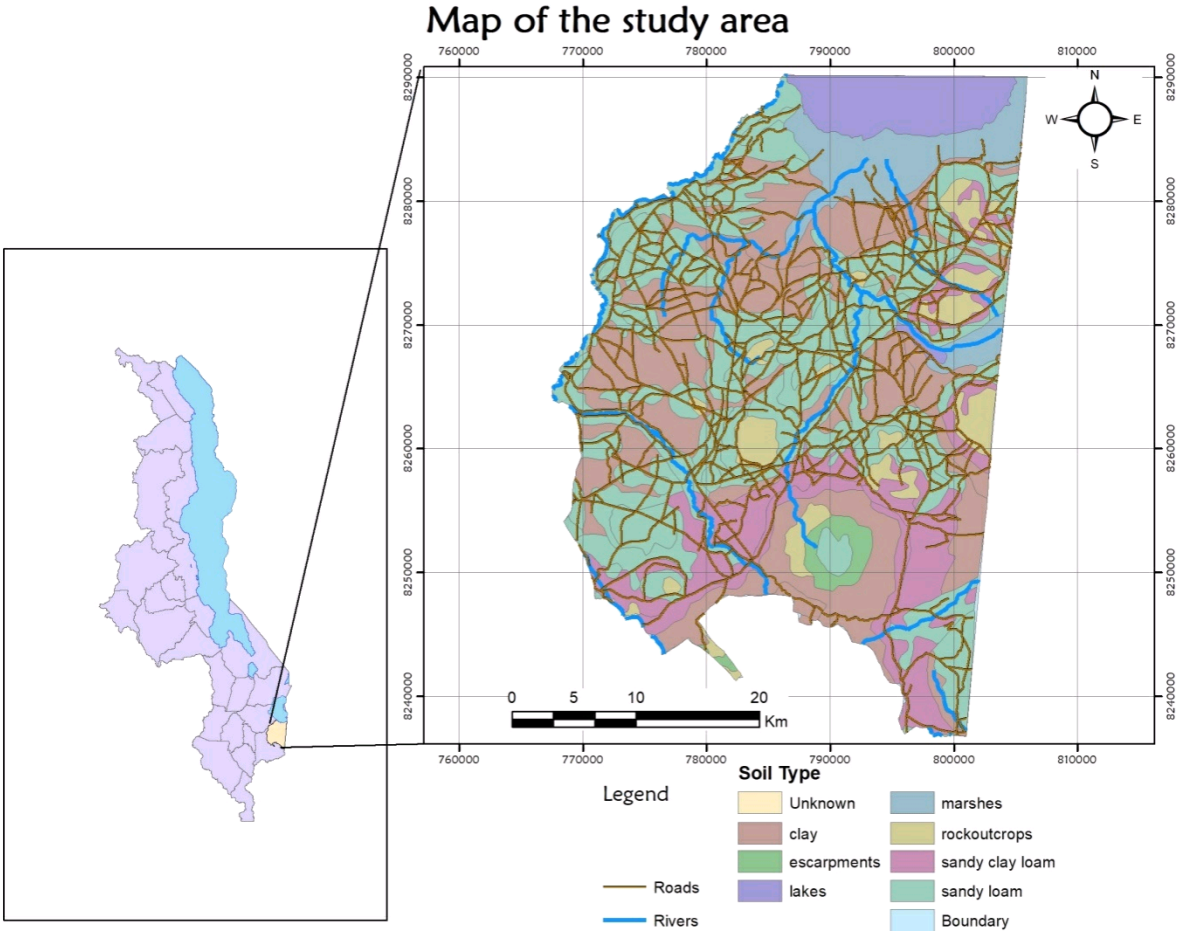



***Figure 1 Study area map***

## 2.2. Soil

Soil is defined as the unconsolidated mineral or organic material on the immediate surface of the Earth that serves as a natural medium for the growth of land plants. The occurrence and distribution of soils in nature varies from location to location. The type of soil depends on the rock type, its mineral constituents and the climatic regime of the area. Different types of soils have different physical and chemical properties. Soil can be described by the relative abundance of solid primary particles it contains. These particles, depending on their size, can be classified as sand, silt, or clay. The relative proportion of sand, silt, and clay in the soil is known as soil texture (agriculture, 2014). These particles are categorized by their sizes, with sand particles being the largest. These soil properties however have different agricultural capabilities and they also respond differently to wide range of human practices (Philip, 1957).

## 2.3. Soil texture, sampling and sieving

Texture is one of the most important properties of a soil, and it greatly affects crop production, land use, and management. Soil texture is directly related to nutrient retention and drainage capabilities (infiltration rate) (Gershuny, 2003). This aspect is studied because the measure of infiltration of water into the soil is an important indication concerning the efficiency of irrigation and drainage, optimizing the availability of water for plants, improving the yield of crops and minimizing erosion. Adequate knowledge of soil infiltration data is essential for reliable prediction and control of soil and water related environmental hazards. This is so because infiltration behavior of the soil directly determines the essential variables such as inflow rate, length of run, application time, depth of percolation and tail-water run-off in irrigation systems. Infiltration rates are influenced by the initial moisture content, condition of the surface, hydraulic conductivity of the soil profile, texture, porosity, degree of swelling of soil colloids, organic matter, vegetative cover, duration of irrigation or rainfall and viscosity of water (Jianfeng & Kenneth, 2008). Of these, soil texture, however, play predominant role. In other words, soil texture, or the percentage of sand, silt, and clay in a soil, is the major inherent factor affecting infiltration. Water moves more quickly through the large pores in sandy soil than it does through the small pores in clayey soil, especially if the clay is compacted and has little or no structure or aggregation. Depending on the amount and type of clay

minerals, some clayey soils develop cracks from shrinkage as they become dry. The cracks are dir

To find soil texture, soil sampling is applied firstly. Soil sampling is the term used to describe the process of taking a small sample of soil, which is then sent to a lab to determine any intended property. A sample is a small part or quantity intended to show what the whole is like. Soil sample therefore is small part of soil to represent the whole. The soil can be tested for the physical, chemical and biological properties (Ferguson, Hergert, Shapiro, & Wortmann, 2007). Soil sampling also determines PH of the soil, humus content, and available lime among others. However, the primary objectives of soil sampling are to determine the average nutrient status and degree of variability in a field. The analysis of the soil is carried out by taking samples of the soil and performing laboratory tests, which is then followed by the interpretation of the results. Soil samples may be collected using a variety of methods and equipment depending on the depth of the desired sample, the type of sample required (either discrete or composite), and the soil type. Near surface soil samples may be easily sampled using a spade, trowel, and/or scoop. Sampling at greater depths may be performed using a hand auger/probe, continuous flight auger, trier, split spoon sampler, or, if required, a backhoe. In general however, the soil probe is the most desirable tool for collecting soil samples. This is so because it will give a continuous core with minimal disturbance to the soil. Cores can be subdivided for various depth increments. However, soil probe cannot be used to sample soil that is too wet, too dry or if it contains gravel. However, an auger can be used instead. Care should also be taken when sampling to avoid contamination. The soil samples should then be taken to laboratory. Soil samples should air dried at room temperature for two to three days. Contamination should also be avoided when air drying the samples. Further analysis can now be held on the air dried samples. One of the major analyses is sieving. Sieving is a physical mechanism of particle removal, where a particle is denied access through a pore or passageway that is smaller than the particle itself. In soil sieving, a stack of test sieves with increasing mesh size is used. The remnants on each sieve are weighed in order to come up with grain size distribution of that soil (Franzluebbers, 2002).

However, in order to know the texture of your soil, its components are classified by their combined percentages into a textural class with the aid of the textural triangle. The triangle has 12 different soil textural classes that are associated with various

proportions of sand, silt, and clay, but soils can be generally categorized as one of the four major te

## 2.4. Infiltration rate and how soil texture affect infiltration rate

Apart from soil texture, infiltration rate is another aspect studied in this research project. Infiltration is the process by which water enters the soil. This aspect is studied because infiltration rate, being a measure of how fast water enters the soil, influences the major mechanisms governing water availability to plants. It decreases with time from the onset of rainfall or irrigation. The rate of decrease depends on several environmental factors such as rainfall rates and pattern or head of water application, soil properties (including soil depth, texture, pore characteristics, organic matter content, and structure), vegetation, land use, temperature, and antecedent moisture (Diamond & Shanley, 1998). The measure of infiltration of water into the soil is an important indication concerning the efficiency of irrigation and drainage, optimizing the availability of water for plants, improving the yield of crops and minimizing erosion. Adequate knowledge of soil infiltration data is essential for reliable prediction and control of soil and water related environmental hazards (Ayu & Prijono, 2013). An infiltration test is the process in which set of materials are used to find infiltration rate. Infiltration rate test should be conducted on native soils i.e. not cultivated. There are also certain times k2when an infiltration test should wait. For example, test should not be done on sites where there was rainfall within past 24 hours neither when ground is frozen. Tests should also be conducted by qualified professionals and technicians e.g. Soil scientists, local regulators, design engineers, and professional geologists (Dagadu & Nimbalkar, 2013). There are many types of tests used to find infiltration rate. These are Percolation test, modified percolation test and double ring infiltrometer test. In this study, the double ring infiltrometer test is used. In a double ring infiltrometer test the vertical infiltration rate is isolated. An inner ring is used to measure water drop over time, and an outer ring minimizes lateral water movement from the inner ring. This method measures the infiltration rate of a very small and specified area. Multiple measurements at different areas of the site may be needed to properly assess suitability.

There are many factors that recent researchers have found to affect infiltration rate. In general, Soil infiltrability is influenced by the rainfall, vegetation type, water content, and soil characteristics. Soil properties that affect the process of infiltration are soil structure, texture, soil organic matter content, bulk density, particle density,

and initial soil moisture content (Adeniji, Umara, Dibal, & Amali, 2013). However, the following secti

# 3. CHAPTER THREE: METHODOLOGY

This chapter explains the methodology that was used in carrying out the research work. It gives an account of the research design, data collection and analysis techniques

## 3.1. Research design

To achieve the objectives mentioned above, this study used a well-designed flow of activities from soil sampling, sample preservation, past soil sample analysis by sieving to find soil textural composition. In general, soil sampling results was to come up with physical properties mainly infiltration and soil texture. The main property was soil texture that was used to correlate with soil infiltration rate. The soil texture was found by analysing soil samples in the laboratory and Infiltration rate was found by

working with infiltration rate data to come up with infiltration rate curves. The soil texture is used to

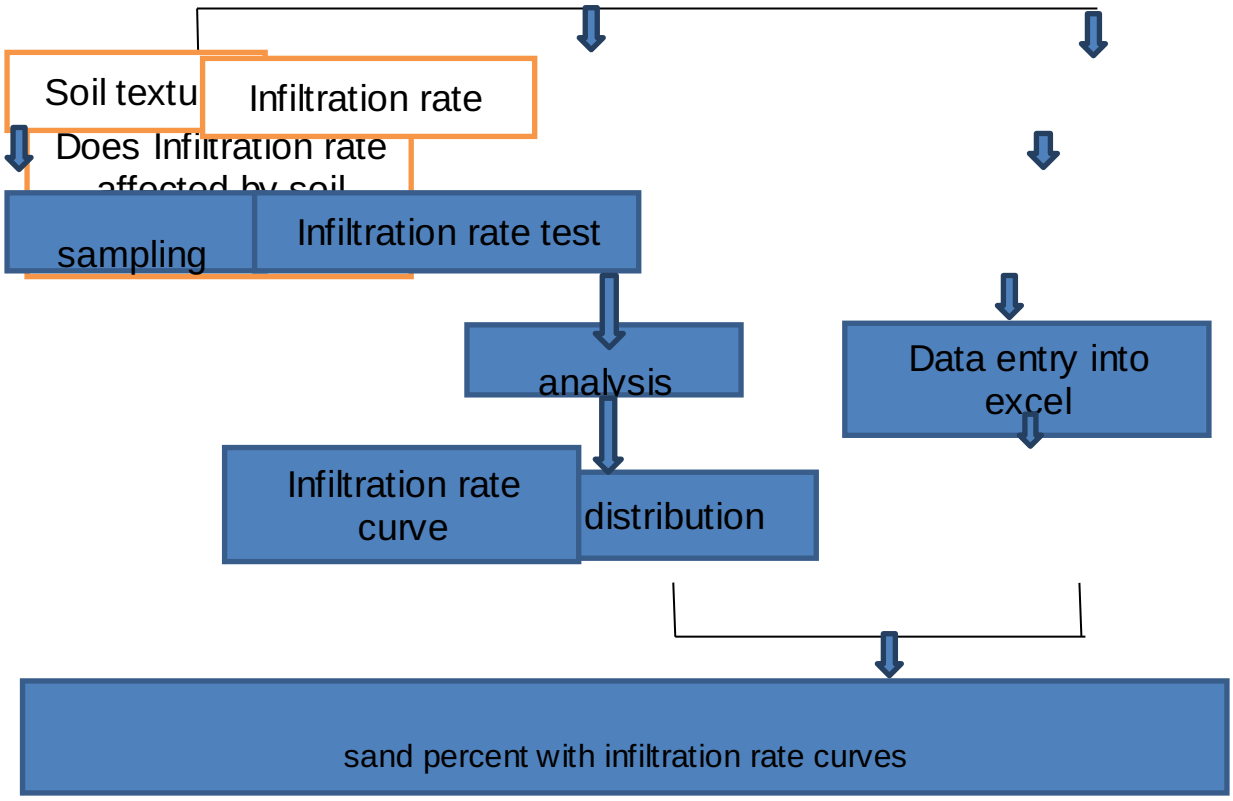



***Figure 2 Flow Chart***

MAP OF PHALOMBE SHOWING SAMPLING POINTS

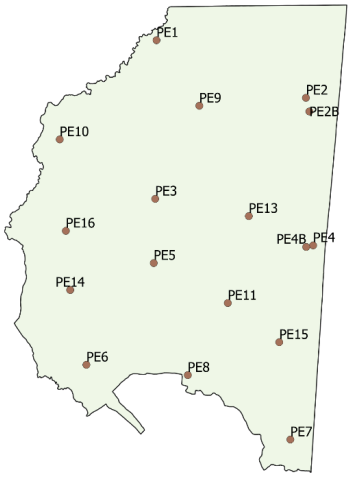


***Figure 3 Sampling points***

## 3.2. Data Collection

### 3.2.1. Sampling Points

Soil sampling was done from 15 locations as in figure 4. Two soil samples were collected from each location, these were collected from 0-15 cm and 15-60 cm. Therefore, a total of 30 soil samples were collected in the study area.

Soil infiltration test was carried out in the same area where soil sampling was done. However due to some soils that were highly cracked, the test couldn't be carried out. Thus, a total of 6 infiltration tests were conducted

### 3.2.2. Materials

The following are the materials used in data collection.

1. Field book and permanent marker
2. Geographic Positioning System (GPS)
3. Soil Auger of screw type.
4. Peak and a hoe.
5. Core samplers and trowel
6. Plastic papers as sample bags.
7. Set of double rings
8. ruler
9. Stop watch
10. Water
11. Field notebook
12. Hammer.
13. Air dried soil samples
14. Scale balance
15. Sieve shaker
16. Test sieves
17. Field notebook
18. A laptop for mapping, data entry and analysis.

### 3.2.3. Soil sample collection

The soil samples were collected on selected few points across Phalombe district using purposive samplinh strategy. However, a visual survey of the field was done before the actual soil sampling. Variation in slope, colour, texture, elevation, cropping system etc. were observed and recorded on soil sample information sheet in the field book. Since the points were already selected before going to the field, a map was there to be used as a guide. A point was tracked using GPS which shows its direction and distance from where the person is to the point. The points were found and below were the sampling procedure:

**Step 1**: Record visual appearance of the area in the notebook, including soil color, soil type, terrain, elevation, vegetation type and previous crop grown in that area. This provides insight of soil type of that place.

**Step 2:** Mark soil auger, into the desired depths to be sampled. In this project, sampled points are 0-30 cm and 30cm – 100m. This is done to check how soil texture changes with depth and be used to compare how infiltration rate changes with time as water percolates into the ground.

**Step 3**: Remove any unnecessary crop residues on the point to be bored, and start sampling as per depth. Place the auger vertically, start pressing it down and rotate it to get soil samples. This is so because the main emphasis was on clay, silt and sand content.

**Step 4**: Collect soil samples from the auger when the desired depth is reached.

**Step 5:** Place the soil samples into well labeled sample bags. The sample bag were labeled with point name, coordinates and its depth. Record observations of samples at each depth when sampling.

A hoe and a peak were used to dig where necessary. They are also advantageous because they can be used to dig large enough pit for profiling. Apart from profiling, core samples are easily taken when a hoe is used. Precaution was also used to avoid sampling cultivated areas since on cultivated areas soil texture is tampered and can bring false results on infiltration rate test. After soil sampling, the soil samples are sent to laboratory for further analysis.

### 3.2.4. Infiltration rate test

Infiltration rate is the speed at which water enters into the soil (Diamond & Shanley,

2015). It estimates the rate at which runoff will infiltrate or pass through native soil. It is measured i

**Materials used in double ring infiltrometer test**

1. Set of double rings
2. ruler
3. Stop watch
4. Water
5. Field notebook
6. Hammer.

Below was the procedure used to conduct infiltration rate test using double ring infiltrometer test:

**Step 1**: Hammer both inner and outer rings into the soil; at least 15cm into the soil. Make sure the rings are hammered on a flat surface and center the inner ring within the outer ring.

**Step 2**: Pour water in the area between outer and inner ring. This water helps to prevent a lateral spread of water from the inner ring through diffusion.

**Step 3**: Pour water in the inner ring, record water level using a ruler, start the stop watch and start recording water depth with time.

**Step 4**: Record water level every unit time set until the end of 2 hours or stop recording when saturation is reached. Saturation point is where there is no change in water depth as time goes.

The infiltration rate raw data (water depth against time) and was later entered in excel onto which infiltration rates were found and plotted. However, some locations may contain large cracks that hinder infiltration rate testing. Also make sure to perform the infiltration rate while there is no rainfall or soil should be in its normal state i.e. not saturated by rain water. The rest soil properties tests are then performed in the laboratory.

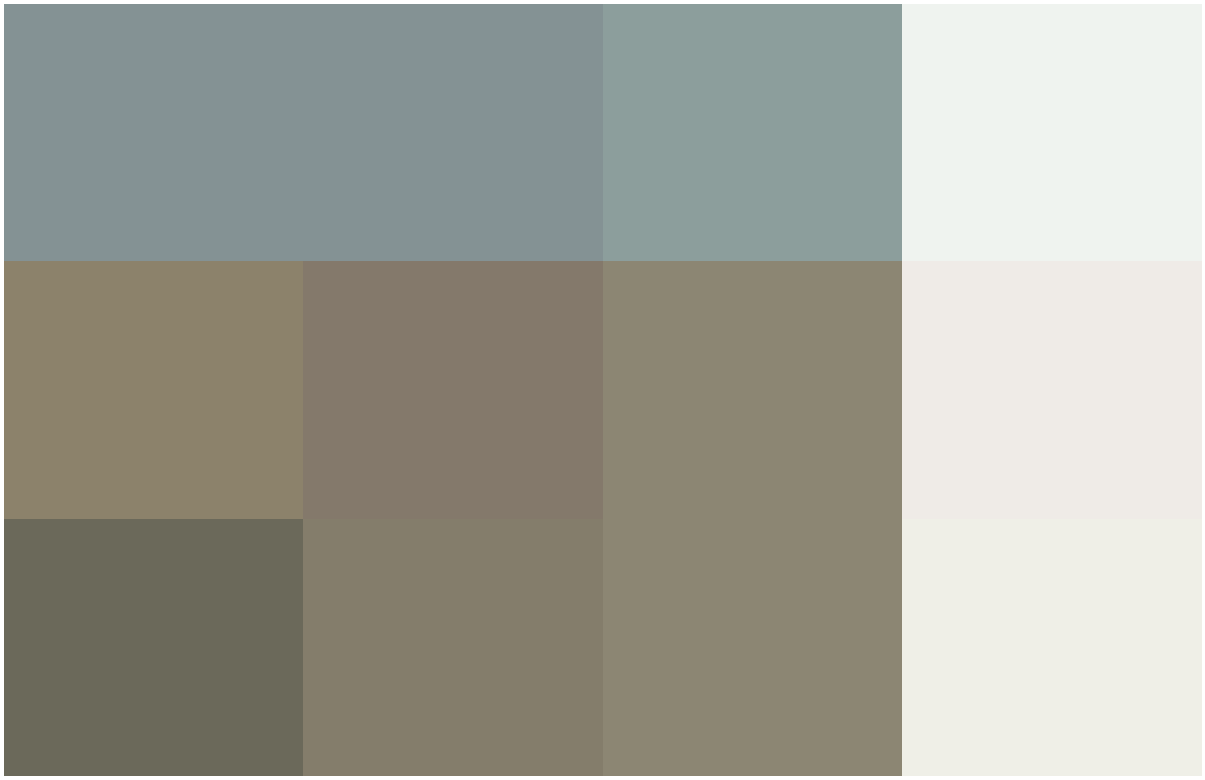


**Figure 4 Infiltration double rings**

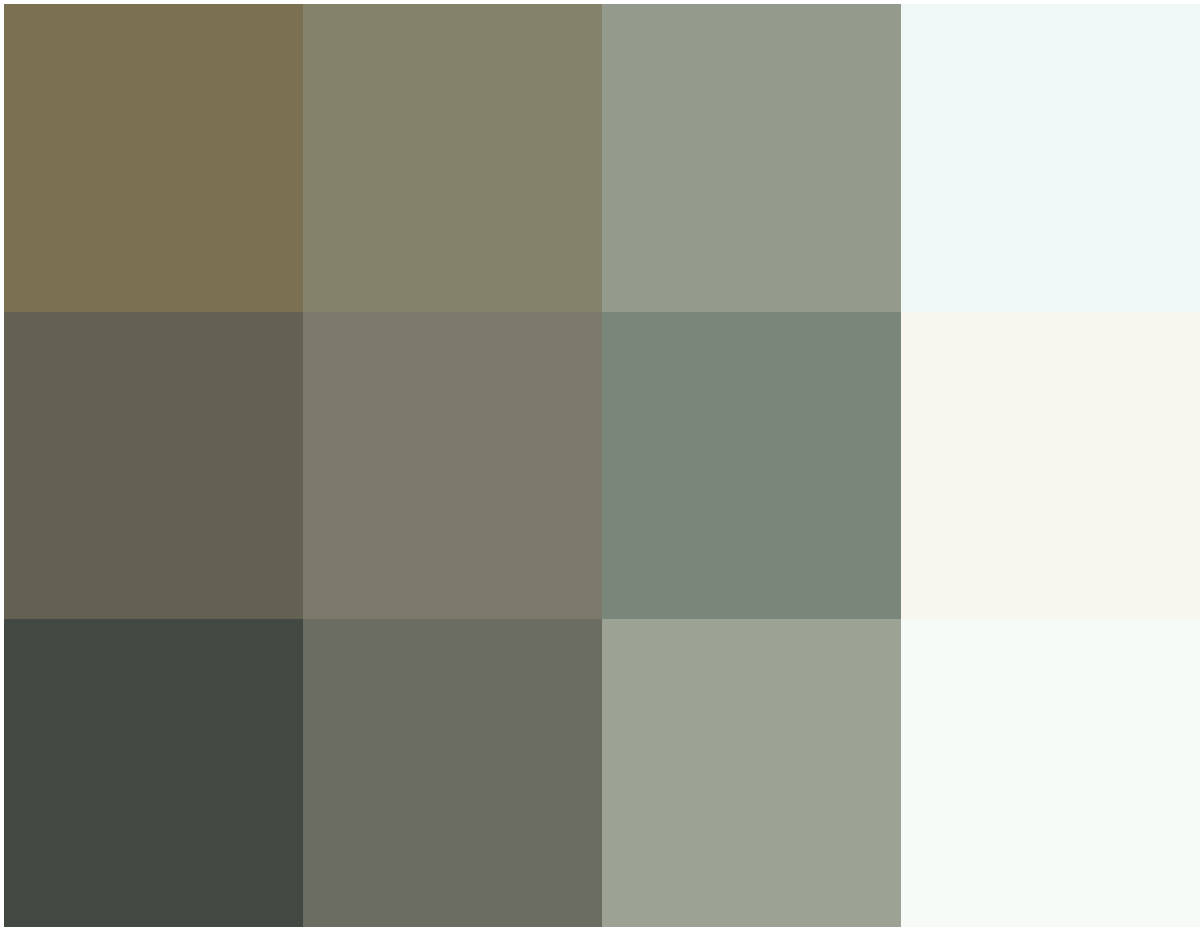


***Figure 5 Infiltration rate test procedure***

## 3.3. Data analysis

### 3.3.1. Soil sample analysis

Soil samples were air-dried before any further analysis. Care was taken so as not to lose the identity of soil samples. Soil samples are analyzed in laboratory to come up with physical data (soil properties) used to predict how it affects infiltration rate and how it affects agriculture. The main emphasis is focused on the following soil

properties: PH, bulk density, sand content, silt content, clay content. Sand content, silt content, cla

**Sieve analysis**

Sieve analysis is a practice or procedure used to assess the particle size distribution of granular material by allowing the material to pass through a series of sieves of progressively smaller mesh sizes and weighing the amount of material that is stopped by each sieve as a fraction of the whole mass (Hillel , 2000).

**Materials used in sieve analysis**

1. Air dried soil samples
2. Scale balance
3. Sieve shaker
4. Test sieves
5. Field notebook.

Below is the procedure used to conduct sieve analysis to come up with the intended soil properties.

**Step 1**: Weigh the mass of a container used to weigh the samples.

**Step 2**: Take a representative air-dried sample and weigh it 500g accurately (the mass of a container used is subtracted to get correct sample weight).

**Step 3**: Break all the lump in the soil sample to be sieved into smaller pieces before they are passed through the sieves.

**Step 4**: prepare the stack of test sieves. The sieves are stacked in order, with the largest size on top and smallest on bottom. A receiver is placed under all sieves to collect samples. 1mm size is placed on top to return sand particles. 0.25mm sieve is placed below 1mm sieve and 0.074mm is placed over the pan.

**Step 5**: weigh all the sieves and receiver (pan) separately.

**Step 6**: pour the samples of know mass into top of the stack of sieves and place the stack in the sieve shaker and fix the clamps, adjust the timer to between 5-10 minutes and switch the shaker on.

**Step 7**: stop the sieve shaker and measures the mass of each sieve and retained soils. The mass of retained soil is found by subtracting mass of sieve from the total mass of sieve and retained soil.

Once the whole procedure has been completed, results are analyzed as follows:

**Percent finer= (**Total mass- retained mass)/Total mass) *100

**Sand percentage**= (mass returned on 2mm sieve/ Total mass) *100

**Silt Percentage**= (Mass returned on 0.02mm sieve/Total mass) * 100
**Clay Percentage**= (Mass passing 0.02mm sieve/Total mass) * 100

The results of soil composition mainly sand content, were used to correlate with how infiltration rates changes with change in soil textural composition. To come up with soil type, soil triangle was used. Figure 6 is the diagram showing soil triangle.
From the soil triangle soil textural compositions are known by placing soil composition at the right triangle. For instance, point 1 had 59.8% sand, 40.25% silt and 24.8% clay. Using the soil triangle this was classifies as sandy loam.

***Figure 6 Soil triangle***

### 3.3.2. Soil Infiltration rate

This study analyzed infiltration rate data using Horton's graphical method. This method estimates infiltration capacity of the soil by plotting the relationship between the infiltration rate and time on the graph as below (Adeniji, Umara, Dibal, & Amali, 2013):



***Figure 7 Basic infiltration rate curve***

The curves produced were related to soil textural composition (in terms of sand percent) of a particular site. The sand percentage used to compare to the infiltration rate curve is found by using the following formula from sieve results:

**Sand percentage**= (mass returned on 2mm sieve/ Total mass) *100

# 4. CHAPTER FOUR: RESULTS AND DISCUSSION

## 4.1. Soil texture from sieving

Soil samples were analysed using sieves in a process called sieve analysis. The Table 2 below shows the results from the sieve analysis. The results are percentages of different soil properties and the type of soil after. Sand contents are the main emphasis of this study. Areas with high and low sand contents can be easily found from the table.

| Name | Depth | Sand percent | Silt percent | Clay percent | Soil type |
|---|---|---|---|---|---|
| PE 1 | 0-30cm | 59.80 | 40.20 | 24.8 | Sandy loamy |
| | 30-100cm | 77.80 | 22.20 | 18.80 | Sandy loamy |
| PE 2 | 0-30cm | 81.80 | 7.40 | 10.80 | Loam sand |
| | 30-100cm | 92.40 | 0.80 | 6.80 | Sand |
| PE 3 | 0-30cm | 61.80 | 23.80 | 14.40 | Sandy loam |
| | 30-100cm | 45.80 | 11.40 | 42.80 | Clay |
| PE 4 | 0-30cm | 53.8 | 11.40 | 34.80 | Sandy clay loam |
| | 30-100cm | 63.8 | 5.40 | 30.80 | Sandy clay loam |
| PE 5 | 0-30cm | 47.8 | 21.40 | 30.80 | Sandy Clay Loam |
| | 30-100cm | 41.8 | 21.40 | 36.80 | Clay loam |
| PE6 | 0-30cm | 61.8 | 19.40 | 18.80 | Sandy loam |
| | 30-100cm | 61.8 | 15.40 | 22.80 | Sandy Clay Loam |
| PE 7 | 0-30cm | 62.4 | 18.80 | 18.80 | Sandy loam |
| | 30-100cm | 61.8 | 8.60 | 29.60 | Sandy loam |
| PE 8 | 0-30cm | 75.2 | 8.00 | 16.80 | Sandy loam |

| | | | | | |
|---|---|---|---|---|---|
| | 30-100cm | 75.8 | 10.40 | 13.80 | Sandy loam |
| PE 9 | 0-30cm | 45.8 | 15.40 | 38.80 | Clay loam |
| | 30-100cm | 36.40 | 10.80 | 52.80 | Clay |
| PE 10 | 0-30cm | 86.4 | 2.80 | 10.80 | Loamy sand |
| | 30-100cm | 85.8 | 1.40 | 12.80 | Loam sand |
| PE 11 | 0-30cm | 75.8 | 10.40 | 13.80 | Sandy clay loam |
| | 30-100cm | 92.4 | 0.80 | 6.80 | Sand |
| PE 12 | 0-30cm | 82.4 | 2.80 | 14.80 | Loam sand |
| | 30-100cm | 74.4 | 4.80 | 20.80 | Sandy loam |
| PE 13 | 0-30cm | 45.8 | 13.40 | 40.80 | Clay |
| | 30-100cm | 55.80 | 9.40 | 34.80 | Sandy cla-y loam |
| PE 15 | 0-30cm | 67.8 | 15.40 | 16.80 | Sandy loam |
| | 30-100cm | 73.8 | 9.40 | 16.80 | Sandy loam |

***Table 1 Soil sieve results***

**Sand percentage map of Phalombe district**

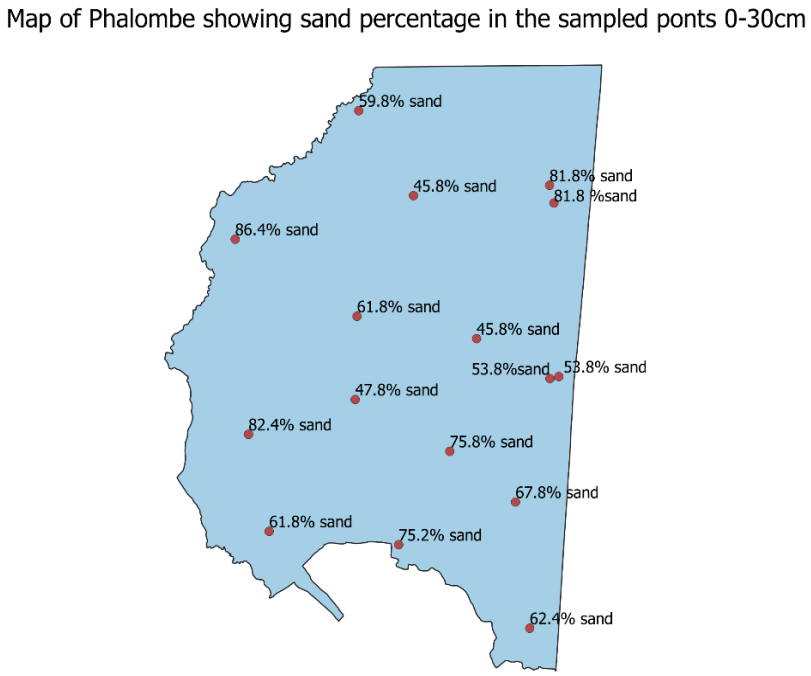



***Figure 8 sand percentage map (0-30cm)***

The map in figure 7 shows percentages of sand, clay and silt. It can be observed that points PE 10, PE 2, PE 8 and PE 11 (0-30cm) have relatively higher percentage of sand particles (86.4, 81.8, 75.2 and 75.8 respectively) than any other points.

Map of Phalombe showng sand percentage of sampled points 30-1m

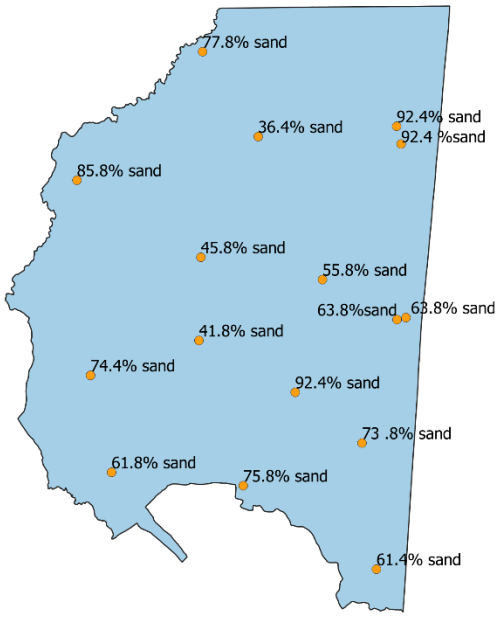



***Figure 9 sand percentage map (30-100cm)***

Similarly as it can be observed from figure 8 for 30-100cm points PE 10, PE 2, PE 1, PE 11, PE 8, and PE 15 at a depth of 30-1m have relatively higher sand percentage (85.8, 92.4, 77.5, 92.4, 75.8 and 73.8 respectively) than any other remaining points. Overall, PE 10, PE 2, PE 11 and PE8 have higher sand percentage in all depth ranges. There is however no threshold value for a point to be said to have high sand content. The point is just related to other points in terms of sand content. The hypothesis is that these points will have high infiltration rate since sand particles allow water to pass through them.

## 4.2. Infiltration rate curves

These are the curves that shows the rate at which water passes through the soil. The graphs in figure 10-13 shows the infiltration rates of two points. They are used to

compare how water infiltrates in areas having different soil compositions. The curves will differentia

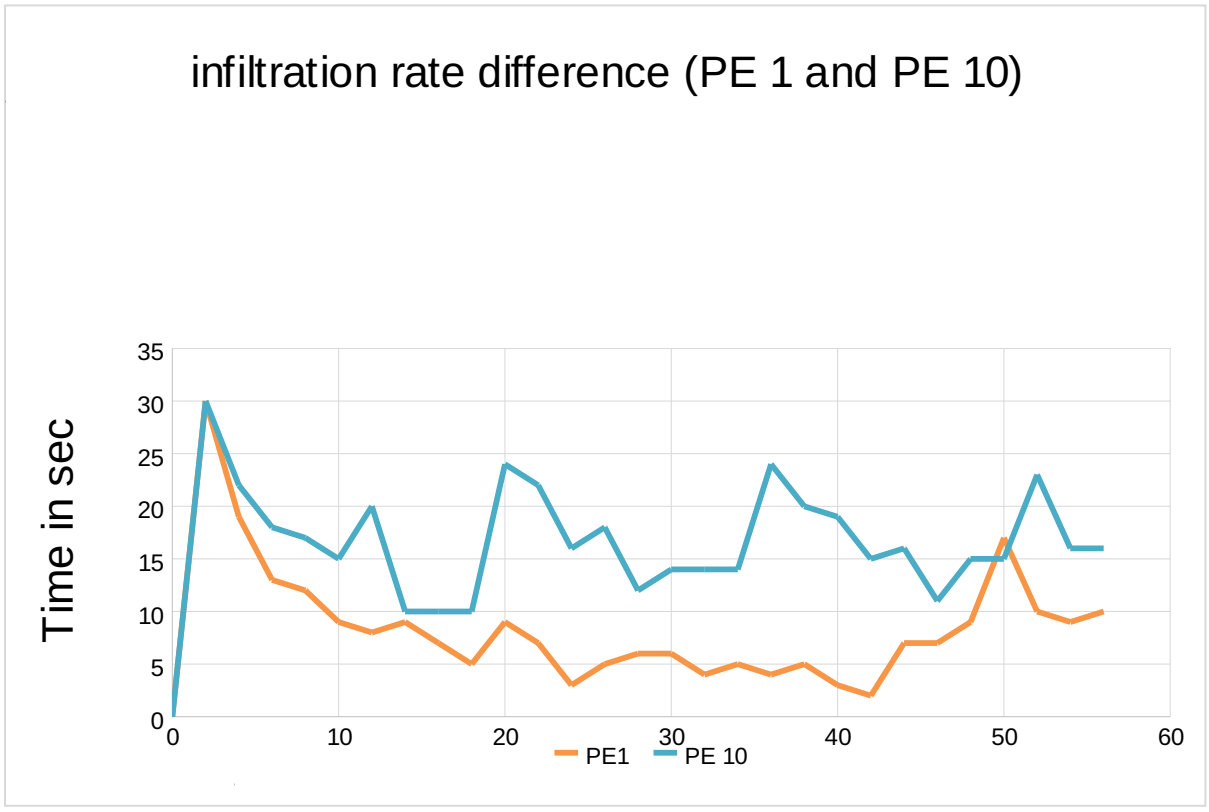



***Figure 10 infiltration rate difference between PE 1and PE 10***

The graph 1 in figure 10 shows infiltration rate curves of points PE 1 and PE 10. PE 1 has lower sand percentage of sand than PE 10. PE 1 has also lower infiltration rate as shown from the graph. This is also evident because infiltration rate test at PE 1 was refilled once while three times at PE 10 which means that water was soaking into the soil faster at PE 10 than at PE 1. This can be concluded that sand percentage or in other words, soil texture, affects the rate at which water soaks into

the soil.

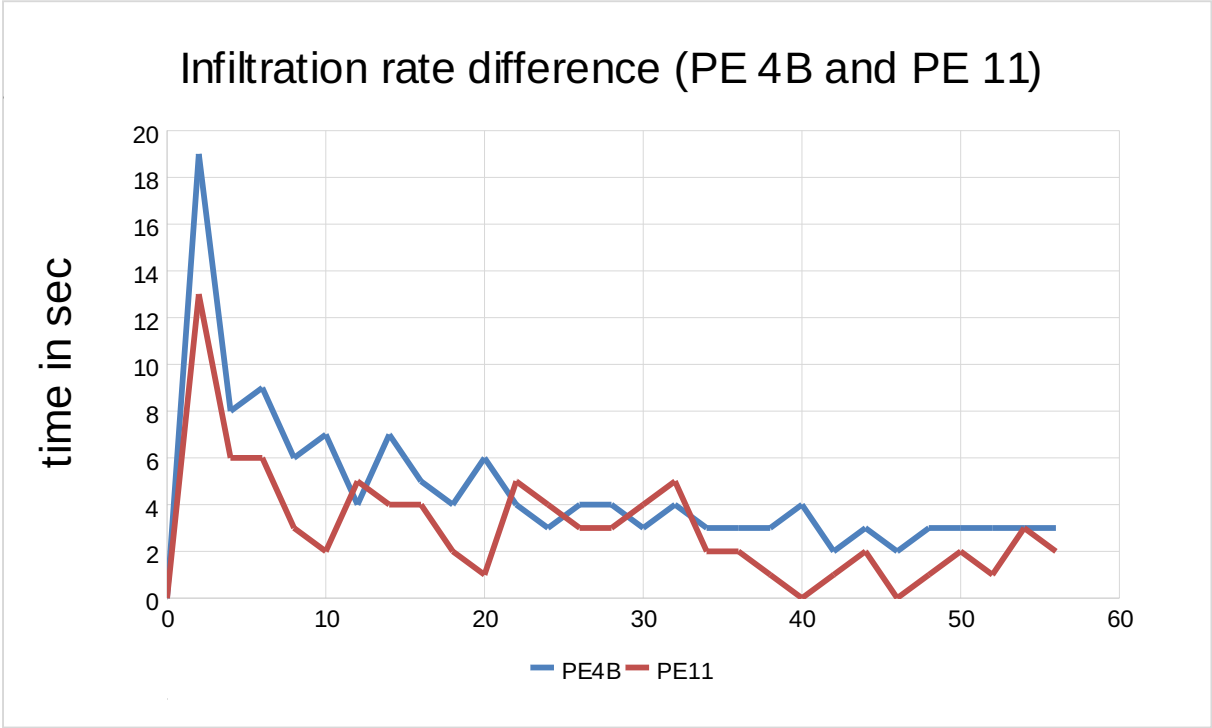



***Figure 11 infiltration rate difference between PE 4B and PE 11***

The graph 2 in figure 11 shows infiltration rate curves of points PE 4 and PE 11. PE 11 has relatively higher sand percentage than PE 4. It can also conclude that sand percentage is related to infiltration rate since PE 4 reaches saturation point where as PE 11 was not saturated. This is so because sand particles at PE 11 does not hold water enough for soil to saturate early.

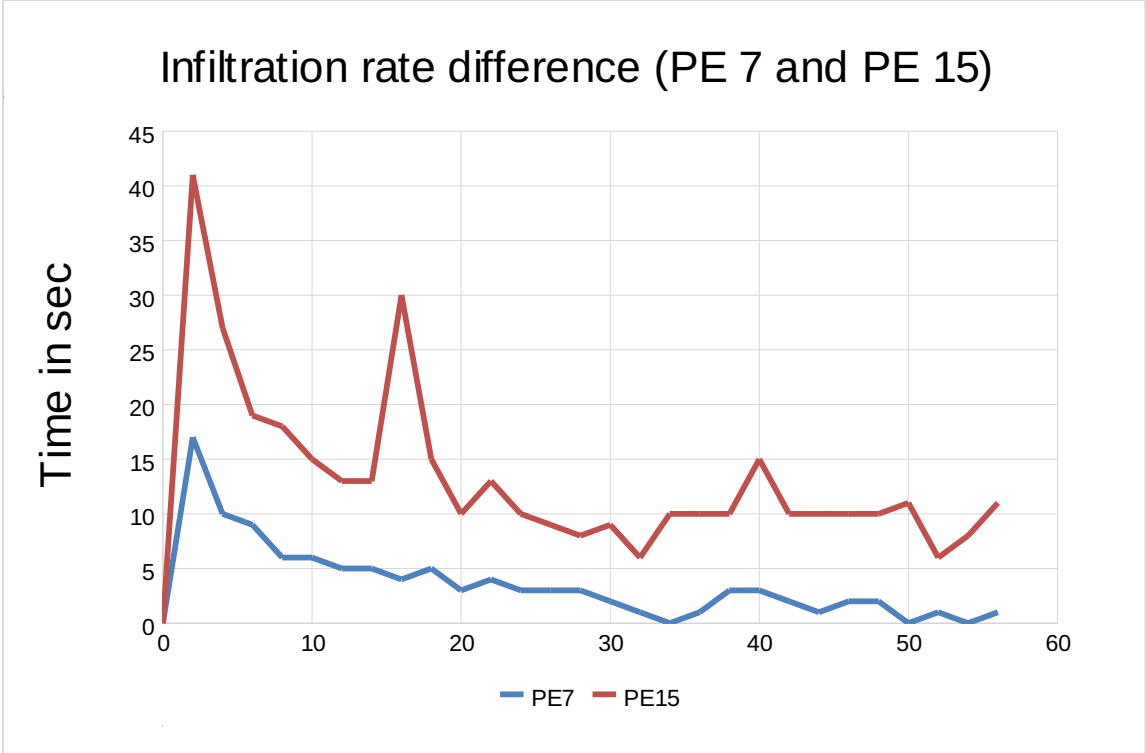
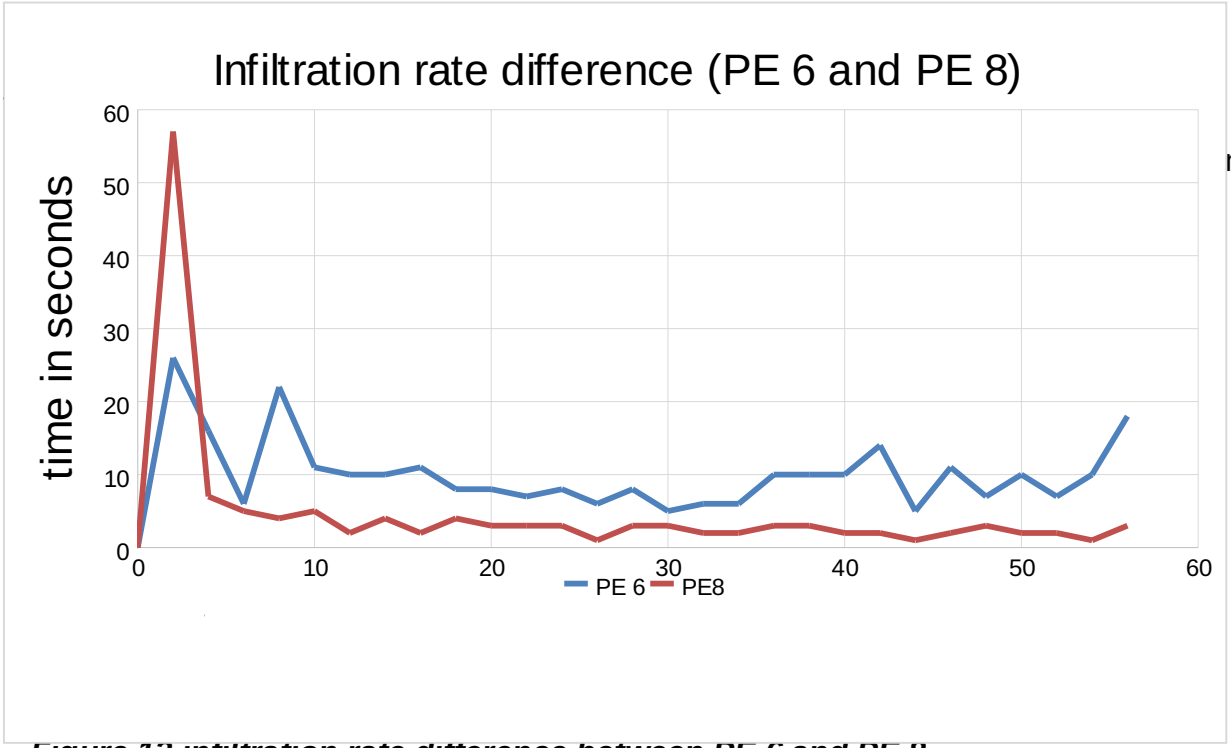



***Figure 12 infiltration rate difference between PE 7 and PE 15***

Graph 3 in figure 12 shows infiltration rate curves for point PE 7 and PE 15. They mainly differ in their sand percentage at depth 30cm – 100cm with PE 15 having higher sand percentage. From the graph, PE 15 has higher infiltration rate than PE 7. This is due to higher sand percentage at depth 30-100cm. It is also evident that sand particles affect rate of infiltration since saturation point was reached earlier at PE 7 while PE 15 the test was refilled twice and saturation point was not reached. It is observed that the infiltration rate at the locations PE 7 is low, because of the predominant existence of clay in the soil which transmits water slowly.

Graph 4 in figure 13 shows infiltration rate curves of points PE 6 and PE 8.




nfiltration rate

***Figure 13 infiltration rate difference between PE 6 and PE 8***

Lastly, at PE 13, PE 3 and PE 9, there was no infiltration rate conducted. This is due to characteristics of the soil. The soils in these locations have expansive clay soils that cracks the soil when dry making it impossible to conduct infiltration rate as in figure 13.



***Figure 13 cracked expansive soil***

The results confirm that the soil textural composition has an effect on soil infiltration rate. However, the results also provide a conclusion that infiltration rate is high during the onset of infiltration rate test.

Firstly, the main result of this study implies that soil with different textural compositions will have different infiltration rates as long as other factors that affect infiltration rate are kept constant. This is also to support an experiment conducted by F. A. Adeniji that there exists a high level of dependence of infiltration rate on the soil fine fraction (Adeniji, Umara, Dibal, & Amali, 2013). This can be supported from this study since the curves of two different sites (PE 1 and PE 10, PE 4B and PE 11, PE 7 and PE 15, PE 6 and PE 8) having different textural compositions are compared. From the curves, water is infiltrating faster in areas with high sand percentage than in areas with low sand percentage. This is also supporting a study carried by Daniel P. Phene who aimed to find out what types of soils would be best for farming. In his conclusion, he found out that the larger particles had a faster infiltration rate (Phene, 2004).

Secondly, the infiltration rate is high during the first few minutes prior the start of infiltration rate test. This means that in dry soil, water infiltrates rapidly. This is called the initial infiltration rate. As more water replaces the air in the pores, the water from the soil surface infiltrates more slowly and eventually reaches a steady rate called basic infiltration rate. As the test continues however, there exists a point where water is saturated in the ground and hence water does not drop in the measuring ruler. This is called saturation point. Different soils with different textural compositions also have different saturation points (with reference to time of start of a test) keeping other factors affecting infiltration rate constant.

In general, the results that soil texture really affects infiltration rate means that the stated hypothesis is true based on the results and from the results from previous works done by independent sources.

# 5. CHAPTER SIX: CONCLUSION

This study aimed at finding physical soil properties of Phalombe district. Physical soil properties were found by conducting soil sampling procedure following sample analysis through sieving in laboratory. Soil texture, which is one of the properties of soil, was found through this process. Secondly, Infiltration rate of the soil was conducted using double ring infiltrometer. This can be seen from this study which used double rings to conduct infiltration rate test in the field. Water level drop was recorded from the inner ring to see how water is soaking in the ground. Through further analysis infiltration rate curves were produced from the data obtained during infiltration rate test. Lastly, from the results on this study, it is conclude that soil texture affects the rate at which water infiltrates through the soil. This can be seen through comparing infiltration rate curves to the sand content of points having different textural composition. From this and other studies, it can be concluded that soil infiltration rate affects how soil behaves in terms of water holding capacity and hence affects agricultural activities.

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