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# ESTIMATION OF SATURATED HYDRAULIC CONDUCTIVITY FOR DIFFERENT SOIL TYPES IN JIMMA ZONE, ETHIOPIA

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***Abstract*— A saturated hydraulic conductivity (Ksat) is the utmost vital soil hydraulic parameter for flow with in the soil. The knowledge of it is vigorous for water resources applications. Numerous methods & models (field, laboratory and empirical formulae) are available for determination of it. However, all of them have their applications and limitations. But, most investigators prefer the usage of empirical formulae to direct measurements of Ksat (field / lab) as direct measurements are very challenging (sometimes impractical), necessitating testing, quantification, and decision; making it extremely difficult to use in hydrologic modeling. Thus, it is vital to effectively asses the illustrative Ksat values matching the cost and its reliability. This study therefore presents the laboratory estimation of the Ksat for different soil textures in Jimma zone (nearby Jimma, Serbo, GilgelGibe and Asendabo towns) in Ethiopia, by both constant head and falling head methods, which are the simplest and cost effective ones. In these procedures, we determined the Ksat values of the soil in the study region. The results indicated that its average values are (1) in between 0.00124 and 0.00173cm/s for sandy-loam soil, and (2) 0.000124cm/s for clay soil. The porosity of soil samples were also calculated and found out to be in the range of 41.25 % and 44.24 % (the average being 43.04%) for sandy-loam soil and 43.54% for clay soil. We then compared the results with the corresponding values in the literature, and finally we concluded that the Ksat and porosity values obtained for the study region were found to be in a good agreement with the corresponding literature values.**

*Keywords:* **Permeability test, Porosity, Saturated Hydraulic Conductivity, Soil textures, Jimma, Ethiopia**

## I. INTRODUCTION

Ksat can be defined as the easiest situation with which voids of saturated soil transport water within it. Basically, it is the constant of proportionality that shows the association of the rate of water flow to hydraulic gradient in Darcy's Law. It is directly related to the effective porosity of the soil [2]. This is often used for the correlation of Ksat values with other hydraulic properties of the soil such as water-holding capacity and drainable pore space [33]. The knowledge of this Ksat parameter is vital (1) for water resources applications like the designs of flood control structures, earthen dams, subsurface drainage systems, etc., (2) for determination of seeping water with in the body earth dams or underground structures built on the coarser foundations, (3) for the estimation of water flow from waste storage arrangements (landfills, ponds, etc.), and (4) for estimation of settlement of deposits of finer soil materials. It can also help provide an improved flood risk management and runoff forecasting. Topography and land use/land cover are amongst the chief factors that influence Ksat of the soils [15, 21]. It is generally the essential element for efficient and effective use of land and better water resources management. However, direct quantification of the Ksat parameter is challenging and expensive[22] under field/laboratory situations, and even it is unfeasible for many hydrologic studies [24]. Due to that, soil researchers and engineers have strongly examined its assessment during the last numerous decades. Accordingly, several models/ pedotransfer functions (PTFs) were established to assess the typical Ksat values with readily available soil information [12, 21, 22, 24, 25, 29].These estimates are mainly based on the grain size of the soil. However, Sobieraj *et al.*[30] assessed the suitability of nine *Ksat* PTFs comprising the Rosetta model in modeling stream flows from rainforest catchment and found them imprecise. Whereas, Minasny and McBratney [16] also investigated eight suggested *Ksat* PTFs using the Australian soil information and obtained that the PTFs of Dane and Puckett (1994), Cosby et al. (1984), and Schaap et al. (1998) showed the good estimates for sandy, loamy, and clayey soils, respectively. The Saxton *et al.* [25] texture based technique of *Ksat* approximation has been effectively implemented to a wide-range of applications. Other approaches have also given comparable outcomes but with limited precision [13, 22]. Jarvis *et al.*[13] examined that few empirical methods to assess the Ksat have been suggested, on the basis of either the particle diameter [3], 'porosity' [2], or water holding parameters of the soil. Nevertheless, these approaches may be more appropriate for forecasting the Ksat, without the effects of macro pore [13]. Ksat was well forecasted with the improved form of Campbell's (1985) technique for Australian soils instead of the particle's geometric mean diameter [29]. Rawls *et al.* [22] suggested a technique to forecast Ksat from bubbling pressure and effective porosity, but the forecasts were not associated with investigational data. It can be renowned that though the assessment techniques of Ksat on the basis of bubbling pressure and pore size distribution index have the benefit of being physically based; such information may not be effortlessly obtainable for bigger areas. Likewise, they might not be so vigorous, as Ksat is inversely associated with the square of the bubbling pressure that in turn is not well-defined by experiments, nor simple to forecast from the substitute variables. Saxton and Rawls [24] carried out an investigation to inform the Saxton *et al.* [25] soil water tension equations from a large USDA soils information and combine the amended Ksat expression of Rawls et al. [21] to give a commonly appropriate estimation technique. Ksat approximations by the Saxton and Rawls [24] approaches were calculated on the basis of %'s of sand and clay, and amended by using %'s of gravel & OM (organic matter), and the bulk density of the soil. In this case, the statistical analyses using measured soil water properties and the USDA soils database yielded correlation coefficients of about 0.6-0.75. The model outcomes varied in their approximation of each of the measured values, indicating that using estimated soil hydraulic properties directly may result in unreasonable errors if not confirmed by validation studies.

Furthermore, three readily applicable models have been developed to accurately describe the relationships between soil texture data and Ksat [2, 25, 29]. Although these models have been widely confirmed, appraised, accepted, and used, their accuracy has been observed to be limited. Duan *et al.* [7] studied to appraise if the Campbell [3], Saxton et al. [25] and Smettem et al. [29] models sufficiently forecast Ksat based soil texture data of Texas lawn soil. The outcome showed that there were relatively large errors when the models were utilized for Ksat estimation. The absolute value of mean relative error for the Smettem and Bristow model (69%) was greater than for the Campbell model (34%) and the Saxton et al. model (36%).

Rawls *et al.* [22] advised that in order to incorporate soil water physics into hydrologic modeling, the relationships between matric potential and Ksat as a function of soil water content must be specified. However, establishing these relationships is both expensive and time-consuming, making this approach unsuitable for use in watershed hydrologic modeling. To overcome these challenges, a thorough search of the literature and data sources for Ksat and related soil-water data was conducted in 1978, with the goal of providing the best estimates possible from the earlier analysis. The Brooks and Corey parameters, soil retention volumes, total porosity, and Ksat for the major USDA soil texture classes were developed from this search [22]. These are the comprehensive typical descriptive results of the soil hydraulic properties well-defined for USDA soil texture classes by joining the outcomes of several research reports in the literature.

Saxton and Rawls [24] showed that using the Ksat data set compiled by Mualem [17], a set of mean Ksat results were established based on the USDA soil texture and were then associated with the investigation result of Rawls *et al.* [22]. The Mualem values were equivalent to those of Rawls *et al.* [22] additionally confirming the appropriateness of Ksat results of Rawls *et al.* [22]. But, the association established by Rawls *et al.* [22] provides a satisfactory estimation Ksat values for applications where further complete information are not obtainable. Since, these results cannot precisely describe the soil hydraulic properties of any specific soil based on the soil texture only, even if the soil texture is the key element. Each soil has additional physical characteristics that may bring the deviation.

Consequently, the accuracy of using indirect methods for Ksat estimation based on soil texture was found to be relatively low. Enormous errors in some cases and better precision in the other cases were detected. In summary, there is no best possible measurement technique for Ksat. These are main reason why many methods/models, as described above, have been established in the past to quantify of the Ksat **[15].** Unluckily, as Ksat is extremely sensitive to sample size, pore geometry, and soil characteristics, these methods/models frequently yield significantly divergent results. Thus, most of the Ksat estimation approaches were found to be neither appropriate for all applications nor precise for all soil types and conditions. Hence, this brief review showed that estimating the Ksat values remains challenging and uncertain, requiring testing, measurement, and judgment. Consequently, expecting extremely high accuracy, regardless of approach, is unrealistic. Thus, it is desirable to effectively assess a representative value of the Ksat while balancing between cost and accuracy. In general, Ksat estimation should carefully be assessed locally to confirm that the values so obtained shall be more accurate and appropriate for the required purpose. Various authors also suggested that, for estimation of Ksat, locally derived equations from readily obtainable soil information can be more precise than using the established estimation models [33]. This paper thus presents the estimation of Ksat for different soil textures in Jimma zone, Ethiopia, by both constant head and variable/falling head permeability test procedures. These test procedures are very simple, practical, cost effective, and are well within the capability of professional engineers and soil scientists, and they can also give the Ksat values with an acceptable accuracy. The constant head test technique is used for soils with the Ksat value more than $10^{-4}$ cm/s and the variable/falling head test technique is chiefly utilized for fine grained soils (Ksat<$10^{-4}$cm/s).

## II. MATERIALS AND METHODS

### *A. The Study Area*

This study was conducted in Jimma zone of Oromia regional state in Ethiopia (Figure 1). Four experimental sites (nearby Jimma, Serbo, Gilgel Gibe and Asendabo towns) were selected for this study. These sites are found in Gilgel Ghibe catchment which has a drainage area of about 2943 $km^2$ at its flow outlet defined by "Ghibe Nr Asendabo" gauging station [20]. Gilgel Ghibe river catchment is one of the tributaries of the Ghibe River [9]. It is geographically located in between $7^0$20´01.58´N to $7^0$59´15.32´´N latitudes and $36^0$31´04.91´´E to $37^o$13`31.07´´E longitudes. It is categorized as high hills with the elevations within 1690m and 3305m a.s.l. The catchment's land-use is consisted of unplanted bare lands (28.6%), forest-lands (13.5%), wood=lands (28.8%), grass-lands (15.7%), and bush/shrub lands (13.1%), and built-up and water (0.3%)[19]. The climate of the catchment is partially humid, warm to hot with average monthly temperature is $19^0$C (minimum 2.5 0C, and maximum $32.6^0$C). Two seasons are known in the catchment; the dry and the rainy. The rainfall is mono-modal rainfall pattern (June-September) called summer. The summer precipitation represents 50-80 % of yearly precipitation aggregates over the catchment [6]. The average yearly precipitation and runoff of the basin are about 1456 mm and 565mm, respectively [20]. Since most of the yearly rainfall happens within June and September months, in these months, catchment-wise strong precipitation continuously happen, in so doing leading to extreme floods. The average yearly evapotranspiration of the basin is roughly 1316 mm, and its main soil categories are Clay, Clay loam, and Sandy loam & Loam (HWSD) [10]. The main socio-economic events in the area are cultivating crops (maize, teff, sorghum, barley, etc.) and rearing of animals [6]. The history of land use and soil management of the selected experimental sites of the catchment indicated that the sites were under continuous cultivation for cereal crops (such as corn, teff, etc.), followed by cattle grazing on grass pasture for the last 10 years. We then intentionally selected two of the experimental sites to be under no-tillage and the other two to be under conventional tillage, each consisted of approximately 10m by 10m. This study was accomplished in months between February and March of 2021 after the corn was planted in February.

TABLE I
DETAIL OF EXPERIMENTAL SITES (JIMMA, SERBO, GILGEL GIBE AND ASENDABO)

| Experimental sites | Longitude | Latitude | Altitude (m) |
|---|---|---|---|
| Jimma | $36^0$50'17" | $7^0$40'30" | 1721 |
| Serbo | $36^0$58'44" | $7^0$41'42" | 1782 |
| GilgelGibe | $37^0$01'16 | $7^0$45'18" | 1694 |
| Asendabo | $37^0$08'17" | $7^0$45'29" | 1778 |

### *B. Experimental Approach*

The Ksat is variable in space and time. Due to that estimation of Ksat is a difficult task involving testing, measurement and judgment. Even though, there are various methods available for estimation of the Ksat, each method/model has its own applications and limitations as described above. Nonetheless, there are relatively simple and low-cost laboratory tests (constant head and falling head techniques) for Ksat estimation. The constant head technique is suitable for relatively more pervious soils, while the falling head is more suitable for less pervious soils. The experiments were conducted in the laboratory of

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Civil Engineering Department, Faculty of Civil and Environmental Engineering, Jimma University, Ethiopia. In this study, the texture class soil was obtained by the hydrometer system. The texture of the soil is the property of a soil used to describe the comparative quantity of different grain sizes of the soil. Particles are arranged into the soil separates as clay [<0.02mm], silt [0.02-0.05mm], and sand [0.05-2.00mm]. The porosity, that shows the percentage volume of voids of the soil sample, was obtained with the help of the saturation method. It dictates how much water is required to saturate the soil material and has a key factor that affect the bulk properties of root zone in the soil. The Ksat was determined for the different soil textures identified from the soil samples collected from the experimental sites using the constant head and the variable/ falling head techniques as briefly described here-under.

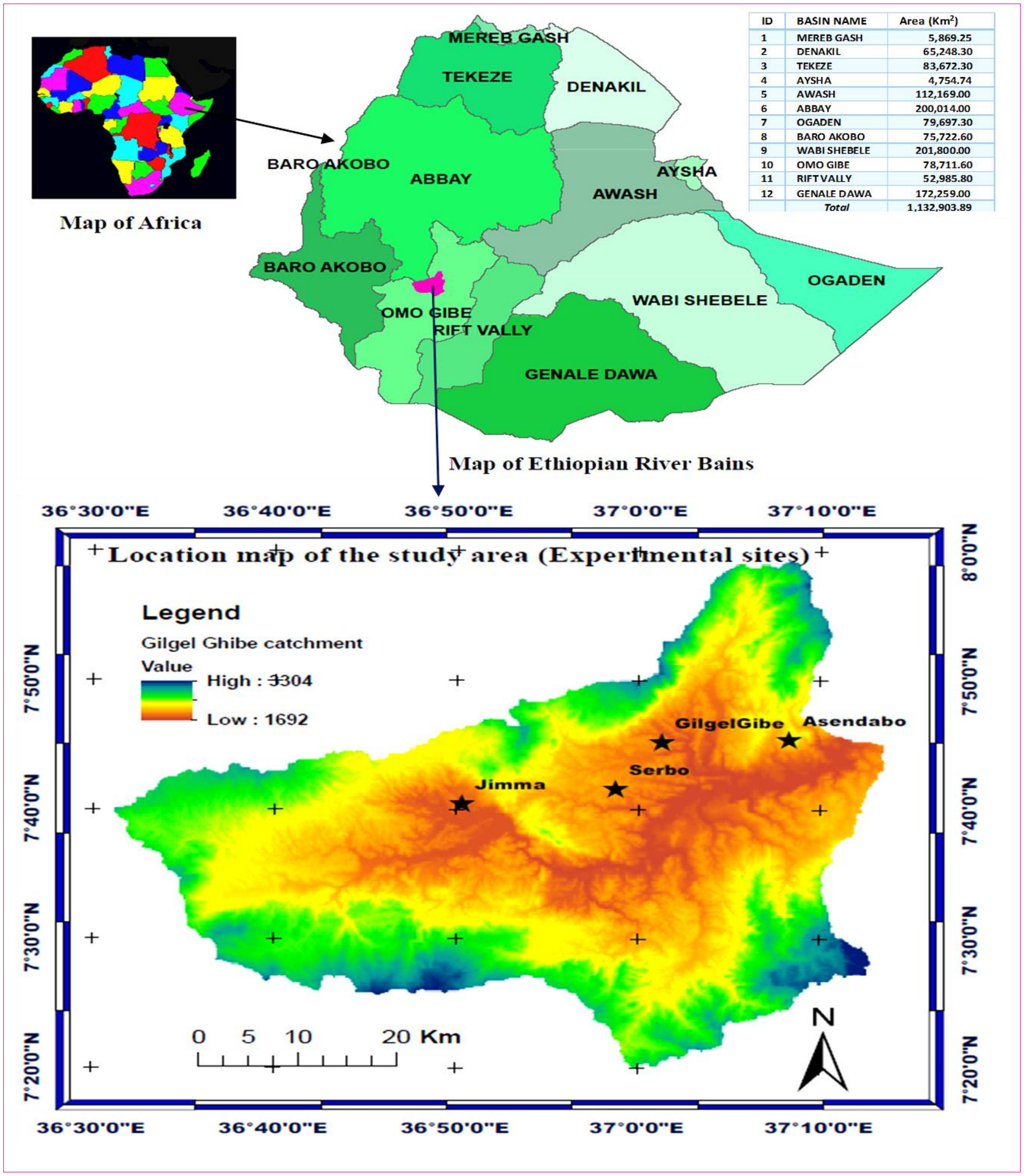



Fig. 1 Locational map of the study-area

### *C. Constant Head Method*

The test in this technique is conducted using the Constant Head Permeameter. Figure 2 (a) demonstrates a diagrammatic illustration of Constant head permeability test. The device is fitted with an adjustable flow of water -reservoir and an outlet that allows preserving a constant head through the test. The procedure allows flow to move through the soil under a steady state condition. In this case, after completely saturating the soil sample, the water was allowed to flow for some time till the steady state flow was achieved. Then, the quantity of water-flow through the column of the soil was measured for specified time interval, ***t***. Measuring the height of the soil column *L*, the cross sectional of the sample ***A***, and the constant difference in the heads of the manometers $\Delta h$, the quantity of water passing through the sample column *V*, and the interval time *t*, the permeability coefficient (*K*) can be calculated by the following expression [23].

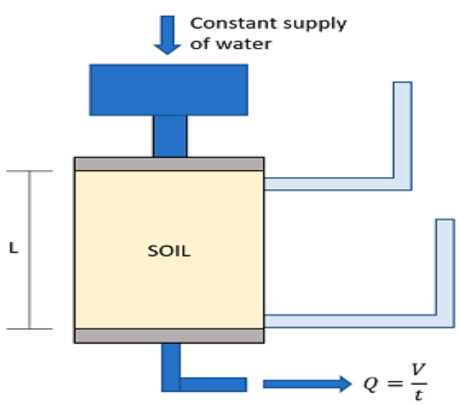
$$K = \frac{Q\ L}{A\ \Delta H} \tag{1}$$

### *D. Falling/Variable Head Method*

This technique is a typical laboratory test for determining the permeability of fine-grained soils such as silt and clay soils. Figure 2 (b) shows a diagrammatical illustration of the test apparatus that works the water head falling over time. In this test, the flow of water through a relatively short soil sample connected to a standpipe that provides the water head and also allows measuring the volume of water passing through the sample is used. The soil sample was saturated before the flow measurements began, and the standpipe was filled to a specified level with de-aired water. The test then began by allowing water to flow through the sample until the water level in the standpipe reached a predetermined lower limit. The amount of time it took for the water in the standpipe to drop from the upper to lower level was timed. The standpipe was frequently refilled, and the test was repeated a few times. The determination of permeability coefficient in this technique can be done by means of the expression [23].

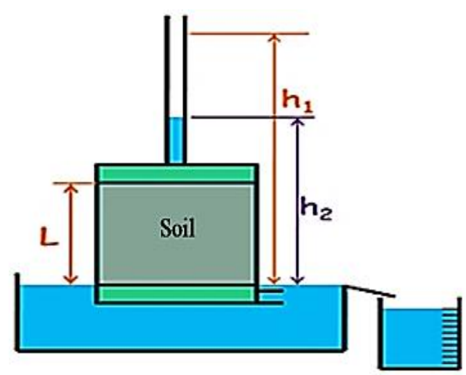
$$\boldsymbol{K = \frac{a\ L}{A\ t}\ ln\left(\frac{h_1}{h_2}\right)} \tag{2}$$

where, *a* is the area of stand-pipe, *L* is length of the column the soil, **A** is the area of soil column, *t* is interval time of the head drop, $h_1$ & $h_2$ are the upper & lower levels of water in the stand-pipe from the reference datum.




Soil

(a) Constant head Method




(b) Falling head method

Fig. 2 Schematic representation of the permeability test

## III. RESULTS AND DISCUSSIONS

Though there have been several efforts to classify the Ksat of the soil referring to USDA classes of soil texture (the easily obtainable property of the soil), the correctness of using such indirect approaches for Ksat estimation based on soil texture only was relatively low. Enormous errors in some cases and acceptable results in the other cases were detected. Thus, Ksat estimation should carefully be done locally to ensure that the information so acquired shall be more accurate and appropriate for the required purpose. Consequently, to achieve the aims of our study, the constant head and the falling head permeability tests were conducted for estimating the Ksat in the laboratory. In this case, the collected soil samples were wisely analyzed using the experimental procedures described above and the results accordingly obtained were tabulated in Table 1 below.

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TABLE II
CHARACTERISTICS OF THE EXPERIMENTAL SOILS COLLECTED FROM STUDY AREA

| Sample # | %Clay (< 0.002mm) | % Silt (0.002-0.05mm) | % Sand (0.05-2.0mm) | Textural Class | Saturated Weight (g) | Dry Weight (g) | Core Volume ($cm^3$) | Porosity (%) |
|---|---|---|---|---|---|---|---|---|
| 1 | 16.20 | 13.20 | 70.60 | Sandy Loam | 109.25 | 92.85 | 37.07 | 44.24 |
| 2 | 15.30 | 12.10 | 72.60 | Sandy Loam | 107.83 | 89.75 | 41.45 | 43.62 |
| 3 | 13.50 | 18.70 | 67.80 | Sandy Loam | 90.65 | 75.17 | 37.53 | 41.25 |
| **4** | **58.50** | **22.00** | **19.50** | **Clay** | **103.82** | **90.75** | **30.01** | **43.54** |

Table II thus explains the physical properties of the collected soil samples from nearby Jimma, Serbo, Gilgel Gibe and Asendabo towns in Jimma zone of Ethiopia. The soil textures of these four locations were obtained to be nearly the same all over the soil profile wherein sandy-loam majorly observed as per results of the analysis. The values of the soil porosity were calculated and found out to be in the range of 41.25 % and 44.24 % (the average being 43.04%) for sandy-loam and 43.54% for clay soil texture classes for the four sampling locations. Following the experimental procedures of the constant head method, the required experimental data that can be used for the estimation of the Ksat by this method were collected from the representative soil samples. Finally, the Ksat values were calculated. The results were shown in Table III with the average Ksat value being 0.0013 cm/s for sandy- loam soil identified in the study region.

TABLE III
KSAT VALUES OBTAINED BY THE CONSTANT HEAD METHOD FOR SOIL SAMPLES #1, #2, and #3

| Test # | Volume of Outflow (cm3) | Sample Length (cm) | Time (min) | Specimen Area (cm2) | Constant Head (cm) | Ksat (cm/s) |
|---|---|---|---|---|---|---|
| 1 | 315 | 8.5 | 5 | 176.72 | 38 | 0.00133 |
| 2 | 615 | 8.5 | 10 | 176.72 | 38 | 0.00130 |
| 3 | 915 | 8.5 | 15 | 176.72 | 38 | 0.00129 |

Figure 3 shows the Ksat estimated by the constant head permeameter for different soil samples, in which the correlation coefficient ($R^2$) of 0.9838 was observed indicating that the estimated Ksat showed good agreement with the temporal variation for the soil samples.

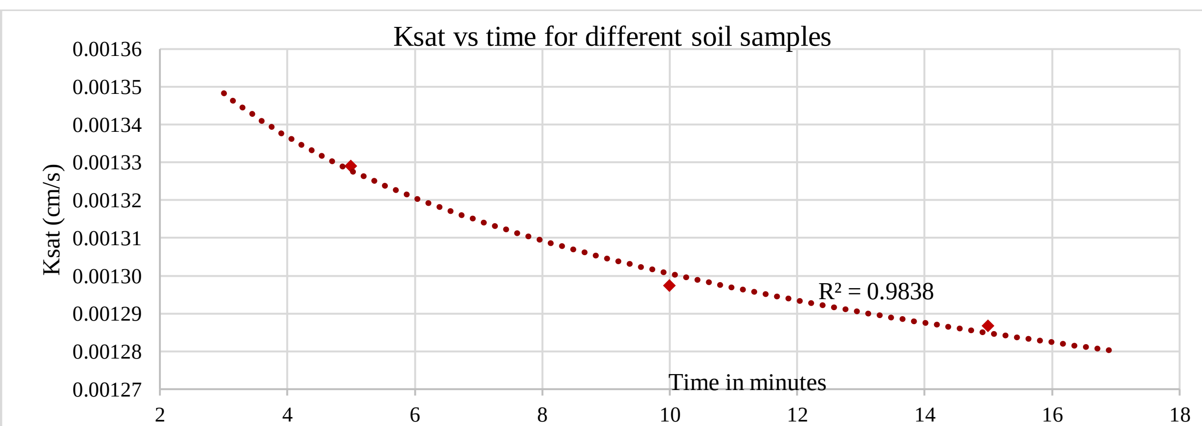


Fig. 3 Ksat Vs time by constant head method for different soil samples

Likewise, the representative Ksat values of the collected soil samples were estimated by the falling head method and the results so obtained were shown in Table IV. In this case, the average Ksat values obtained were 0.0124cm/s, 0.00173cm/s, 0.00147cm/s and 0.0000124cm/s for samples #1, #2, #3 and #4 respectively. These results indicate that the Kast values seem to be within 0.00124-0.00173 cm/s for sandy-loam soil and 0.000124cm/s for clay soil texture classes detected in the study region**.** The Ksat vs time plot for this method was also indicated in Figure 4 in that the estimated Ksat values revealed good agreement with the temporal variation for the soil samples.

TABLE IV
Ksat VALUES DETERMINED BY THE FALLING HEAD METHOD FOR DIFFERENT SOIL SAMPLES

| Test No. | $h_1$ (cm) | a ($cm^2$) | L (cm) | A ($cm^2$) | t (sec) | $h_2$, Sample #1 | Ksat, Sample #1 | $h_2$, Sample #2 | Ksat, Sample #2 | $h_2$, Sample #3 | Ksat, Sample #3 | $h_2$, Sample #4 | Ksat, Sample #4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 99 | 0.342 | 15 | 31.65 | 30 | 75 | 0.0015 | 70 | 0.001873 | 72 | 0.001721 | 96 | 0.000166 |
| 2 | 99 | 0.342 | 15 | 31.65 | 60 | 65 | 0.001137 | 53 | 0.001688 | 59 | 0.001398 | 95 | 0.000111 |
| 3 | 99 | 0.342 | 15 | 31.65 | 90 | 54 | 0.001092 | 40 | 0.001632 | 48 | 0.001304 | 94 | 0.000093 |
| | | | | | Ksat-average | | **0.001243** | | **0.001731** | | **0.001474** | | **0.000124** |

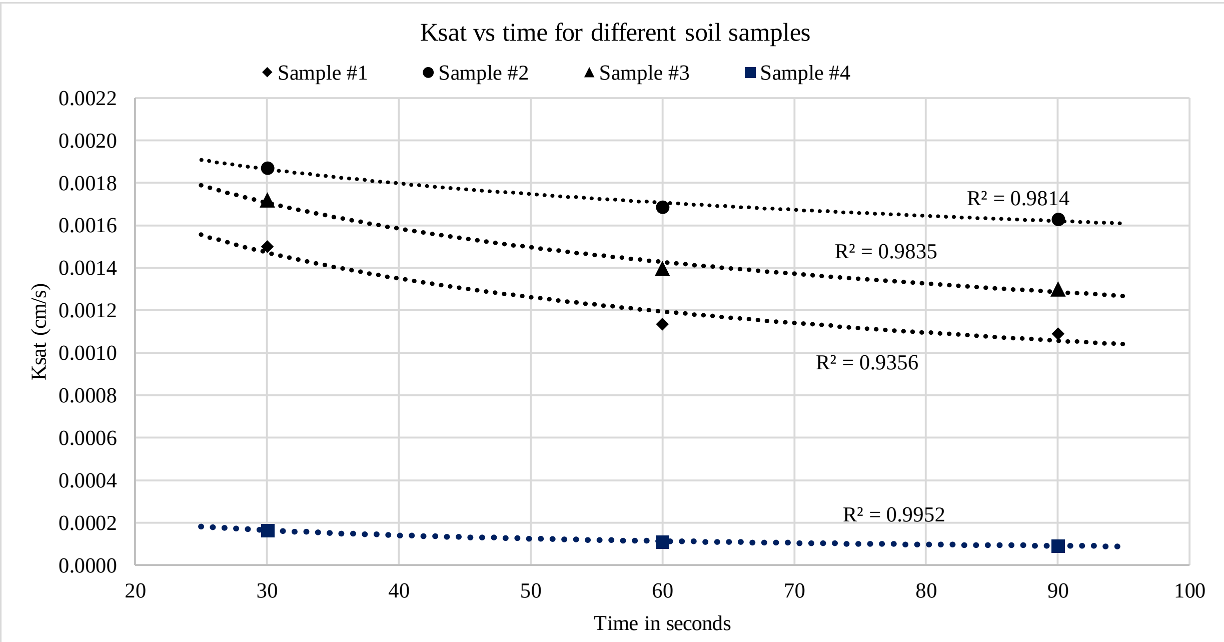


Fig. 4 Ksat values vs time by the falling head method for the experimental soil samples

Lastly, comparisons of the obtained results of the Ksat and porosity values with the corresponding literature values by Brooks–Corey model, Broadbridge–White model, Clapp–Hornberger model and vanGenuchten model (most frequently used models as indicated in Table V) [28] was also carried out in Table VI. The overall result of the comparisons revealed that the Ksat and porosity values acquired in this study showed good agreement with those of the corresponding literature values for study region.

TABLE V
LITERATURE REPRESENTATIVE *Ksat* AND *POROSITY* VALUES FOR 11 USDA SOIL CLASSES [28]

| Soil classes | Clapp–Hornberger model | | Brooks–Corey model | | Broadbridge–White model | | van Genuchten model | |
|---|---|---|---|---|---|---|---|---|
| | Ksat (cm/s) | Porosity (%) | Ksat (cm/s) | Porosity (%) | Ksat (cm/s) | Porosity (%) | Ksat (cm/s) | Porosity (%) |
| Sand | 1.76E-02 | 39.50 | 5.83E-03 | 43.70 | 1.76E-02 | 35.00 | 8.25E-03 | 43.00 |
| Loamy sand | 1.56E-02 | 41.00 | 1.70E-03 | 43.70 | 1.56E-02 | 40.00 | 4.05E-03 | 43.00 |
| Sandy loam | 3.47E-03 | 43.50 | 7.20E-04 | 45.30 | 3.50E-03 | 45.00 | 1.23E-03 | 41.00 |
| Loam | 7.20E-04 | 48.50 | 1.90E-04 | 46.30 | 7.20E-04 | 47.00 | 1.25E-04 | 45.00 |
| Silt loam | 6.95E-04 | 45.10 | 3.67E-04 | 50.10 | 6.95E-04 | 45.00 | 2.89E-04 | 43.00 |
| Sandy clay loam | 6.30E-04 | 42.00 | 1.20E-04 | 39.80 | 6.30E-04 | 40.00 | 3.63E-04 | 39.00 |
| Clay loam | 1.70E-04 | 47.70 | 6.39E-05 | 46.40 | 1.70E-04 | 45.00 | 1.97E-05 | 43.00 |
| Silty clay loam | 2.45E-04 | 47.60 | 4.17E-05 | 47.10 | 2.45E-04 | 50.00 | 7.18E-05 | 41.00 |
| Sandy clay | 2.17E-04 | 42.60 | 3.33E-05 | 43.00 | 2.17E-04 | 45.00 | 3.37E-05 | 38.00 |
| Silty clay | 1.03E-04 | 49.20 | 2.50E-05 | 47.90 | 1.03E-04 | 50.00 | 5.78E-06 | 36.00 |
| Clay | 1.28E-04 | 48.20 | 1.67E-05 | 47.50 | 1.20E-04 | 50.00 | 5.56E-05 | 38.00 |
| Sand | 1.76E-02 | 39.50 | 5.83E-03 | 43.70 | 1.76E-02 | 35.00 | 8.25E-03 | 43.00 |
| Loamy sand | 1.56E-02 | 41.00 | 1.70E-03 | 43.70 | 1.56E-02 | 40.00 | 4.05E-03 | 43.00 |

TABLE VI
COMPARISONS OF THE EXPERIMENTAL Ksat AND POROSITY VALUES WITH THOSE IN THE LITERATURE

| Soil classes | Observed Data | | Brooks–Corey model[28] | | Clapp–Hornberger model[4] | | Brooks–Corey model[28] | | Broadbridge–White model[28] | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Ksat (cm/s) | Porosity (%) | Ksat (cm/s) | Porosity (%) | Ksat (cm/s) | Porosity (%) | Ksat (cm/s) | Porosity (%) | Ksat (cm/s) | Porosity (%) |
| Sandy loam | 1.24E-03 - 1.73E-03 | 43.04 | 3.47E-03 | 43.50 | 7.20E-04 | 45.30 | 3.50E-03 | 45.00 | 1.23E-03 | 41.00 |
| Clay | 1.24E-04 | 43.54 | 1.28E-04 | 48.20 | 1.67E-05 | 47.50 | 1.20E-04 | 50.00 | 5.56E-05 | 38.00 |

## IV. CONCLUSION

Ksat is the key vital soil hydraulic parameter for flow in soil. The various methods & models available for determination of the Ksat were briefly reviewed to confirm the appropriateness and suitability of them. This critical review shows that all of them have their individual applications and limitations. Even though, most researchers prefer the use of empirical formulae to direct measurement of soil Ksat (field or lab) as the direct measurement is very challenging and occasionally unfeasible for many hydrologic analyses, it has been argued that the Ksat estimation of soil should depend on the local soil information. This study thus presents the estimation of the representative Ksat for different soil textures in Jimma zone (nearby Jimma, Serbo, GilgelGibe and Asendabo towns) in Ethiopia, by both the constant head and the falling head methods, which are relatively simple and low-cost for estimation of the Ksat of the soil. The textural classes of the soil were obtained by hydrometer technique, and showed sandy-loam & clay soil. The porosity of soil sample was calculated and found out to be in the range 41.25 % and 44.24 % (the average being 43.04%) for sandy-loam and 43.54% for clay soil textures for all of the experimental/sampling locations. The Ksat values of the soil samples were also estimated by both the constant head and the falling head methods. The results obtained indicated that its average values are within 0.00124cm/s and 0.00173cm/s for sandy-loam soil, and 0.000124cm/s for clay soil. We then compared the results accordingly obtained with the corresponding values in the literature. We finally concluded that the results of the Ksat and porosity values obtained in this study were found to be in a good agreement with the corresponding literature values.

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