Research Open Journal of Science and Technology
Vol. 1, No. 4, October 2013, PP: 37 - 50
Available online at http://scitecpub.com/Journals.php

Research article

MODEL VALIDATION OF VOID RATIO INFLUENCE ON E.COLI TRANSPORT ON HOMOGENEOUS SOIL IN UPLAND AREA OF RIVERS STATE, NIGERIA

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Abstract

Model validation of void ratio influence on E.coli transport on homogenous soil has been examined, the results compared favourably well with results from other locations, the predictive model were generated from experimental analysis, this results were plotted, and it produced a model equations, the model equation were resolved and it produced theoretical values. The theoretical values were compared with a standard experimental void ratio, validation of the predictive model shows the rate of void ratio influence on microbial transport including the degree of void ratio at different soil formations in homogenous soil, it has shown the rate of hydraulic conductivity that influence the rate of microbial transport to ground water aquifer in homogeneous formation. The hydraulic levels including its conductivity from the study definitely reflect on the rate of pollution transport of E.coli in soil structural deposition.

Keywords: E.coli, soil, Nigeria

1. Introduction

Soils play a very important function in the quality of our surroundings. For instance, soil impact the superiority and quantity of our food, and provide a basics structures, as well as interact with the hydrosphere and atmosphere. Soil can be a foundation, a sink, or an interacting medium for many nutrients, as well as contaminants that impact humans, plants, wildlife, and other organisms. An understanding of soil properties and processes is therefore serious to the assessment of the criteria to be adopted for the soil management. The purpose of the study is to be aware of chemical and biological reactions that may pressure the behaviour of contaminants according to the different soil types and properties. Because soil is significant for cultivation and agricultural production, soil fertility and efficiency are important issues to address. Detailed pedological knowledge is useful for land assessment purposes, i.e. the categorization in fertile productive soils and less valuable soils. Soils are an integral part of landscapes and the knowledge of the allocation of different soils helps to preserve a high standard in environmental quality. For example, site specific management cannot be developed without detailed knowledge of soils. Critical sites, e.g. shallow hillslope soils prone to erosion and leaching of nutrients, can be identified using pedology. Soil surveys furnish basic inputs to soil conservation planning and

Although groundwater is a renewable resource, fear is being nursed about its imagined danger in case of inadequacy. The universality of its utility heightens the degree of fear as no other fluid can replace the uncountable roles played by water in the life of plants and animals. Groundwater is ubiquitous but sometimes its availability in economic quantity depends solely on the distribution of the subsurface geomaterials which are referred to as the aquifers. This implies that where groundwater is not potentially endowed enough, there may be either complete lack or inadequacy due to increasing industrial and domestic needs (Akpan et al, 2006, George et al 2010). The thickness and the distribution of water bearing geomaterials sometimes do not really predict the potential reserve since some of the delineated aquifer might be ideally non porous, dry and non prolific (Peritelis et al 2007). The determination of porosity of the saturated delineated geomaterials is the sure way of estimating the usable capacity of aquifers and the groundwater reserve in a given area (Hago, 2000). This traditional technique measures the geometry of the aquifer and the portion of it that is saturated with groundwater which is now gradually replacing the surface water that is degraded in many ramifications. This work was carried out to ward off the uncertainty in the availability of water in the study area. Before now, several hydrogeological studies in the area were all about estimation of ensemble of sand grains and the aquifer potential based on the surficial measurements of aquifer lithological attributes such as resistivity, thickness and depth of the aquifers (Evans et al 2010, Esu and Edet 1999, George et al 2010). This present work is practically conceived to quantitatively estimate the natural reserve of groundwater in the economically exploited depths of aquifer and this makes it unique and different from the previous geophysical studies in the area. Successful exploration, exploitation and management of groundwater require a good knowledge of the spatial distribution of aquifer hydraulic parameters such as lithology thickness, usable capacity and other hydraulic properties. Where such information is not available, geophysical surveys should be performed. Drilling and pumping tests are commonly used for evaluating aquifer characteristics. However, they are time and costconsuming (yang and Lee 2000). Electrical resistivity is widely considered as a useful parameter for hydrogeogical studies because the value is mainly controlled by lithological conditions of the aquifer. It also can be useful in correlating lithological facies between wells Fred, 1993, El Gamili, 2001). Thus, the geoelectrical column and cross-sections deduced from the vertical electric sounding (VES) can provide an effective way to image the vertical and lateral variations of subsurface hydrolithology with a minimum need of observation wells. However, resistivity values are also sensitive to the porosity and water content of the aquifer as well as to the mineralization and salinity of groundwater Mcneill.1980, Parasius, 1997.Pasdyakova et al 2001 Choudhurry, 2004). Because of such complicated factors affecting the resistivity values, the lithology and water quality effects cannot be differentiated by the geoelectric resistivity survey alone (Choudhurry, 2004 George et al 2011).). For an affective use of geoelectric resistivity data to the hydrogeologic study, the correlation between the real data lithology logs and the field data is strongly recommended. The main purpose of the present study is to provide information on the subsurface lithology and groundwater reserve for hydrogeologic interpretations using the integration of the geoelectric resistivity measurements, direct observation of lithology from borehole information and the laboratory measurements on the core samples obtained from the boreholes within the study area. A discussion on the relationship between th resistivity data obtained indirectly and the information obtained from the drilled hole is necessary in this work to evaluate the usefulness and limitation of the earth resistivity data in subsurface hydrogeologic investigations. The study area lies between longitudes 7o451 to 8o101E and latitudes 4o30' to 5o10'N. The geology of the area is Recent to Tertiary Sediments belonging to the Benin Formation. This formation is the youngest geologic unit in the Niger-Delta Sedimentary Basin. This formation comprises continental sand and gravel, deposited on the upper deltaic plain environment. The grain sizes range from coarse to fine sand in textures and are poorly sorted (Reijers, 2004). They are also thick and friable with minor intercalations of clay, silts and sandstones in the area mapped. The alternative sequence builds up multiple-aquifer systems with various thicknesses Griffiths and King, 1985, Okereke, 1998). Thus in the study area, the aquifer systems have been found to be a combination of ensemble of different grain sizes of sands. The survey area sits on a relatively flat terrain and is drained actively by the Kwa Ibo River. It has humid tropical climate, characterized with two distinct seasons – the wet and dry seasons. Most of the coastal areas in the study area usually have salt-fresh water interface at certain depths. The aquifers are predominantly unconfined to semi-confined and this makes them to be water table aquifers. The static water levels in the area have minor variations and the results are minor hydraulic gradients observed in the area. The general recharge is from the surface flows and from the rivers which surround the study area (Mbonu, 1997).

2 Material and Method

Sample were collect from a bore hole drilling site for ten locations through method of insitu method of sample collection, ten sample were collected in sequence of three metres each, the sample were subjected to standard laboratory analysis for void ratio, the experiment performed for the two parameters were to determine the rate of influence on this two parameters for microbial transport to ground water aquifers on homogeneous deposition. The values were plotted and it generates model equations, the equations were resolved and the resolved equations produced theoretical values.

3 Results and Discussion

Results and tables on void ratio are presented in tables and figure shown bellow.

Table: 1 Comparison of Theoretical and measured values of void ratio at Different Depth s

Depth (m)	Theoretical Values	Measured values
3	0.27	0.23
6	0.29	0.26
9	0.32	0.31
12	0.34	0.32
15	0.37	0.38
18	0.39	0.41
21	0.42	0.39
24	0.44	0.44
27	0.46	0.45
30	0.49	0.47

Table: 2 Comparison of Theoretical and measured values of void ratio at Different Depth s

Depth (m)	Theoretical Values	Measured values
3	0.43	0.45
6	0.35	0.37
9	0.28	0.26
12	0.2	0.18
15	0.14	0.16
18	0.008	0.01
21	0.003	0.005
24	0.003	0.004
27	0.003	0.002
30	0.005	0.003

Table: 3 Comparison of Theoretical and measured values of void ratio at Different Depths

Depth (m)	Theoretical Values	Measured values
3	0.34	0.32
6	0.3	0.31
9	0.27	0.29
12	0.1	0.12
15	0.1	0.13
18	0.24	0.25
21	0.21	0.23

24	0.18	0.21
27	0.12	0.14
30	0.06	0.04

Table: 4 Comparison of Theoretical and measured values of void ratio at Different Depths

Depth (m)	Theoretical Values	Measured values
3	0.33	0.34
6	0.41	0.39
9	0.46	0.45
12	0.51	0.52
15	0.54	0.53
18	0.59	0.61
21	0.67	0.68
24	0.78	0.76
27	0.94	0.93
30	1.16	1.14

Table: 5 Comparison of Theoretical and measured values of void ratio at Different Depth s

Depth (m)	Theoretical Values	Measured values
3	0.003	0.005
6	0.006	0.008
9	0.009	0.1
12	0.12	0.13
15	0.015	0.017
18	0.018	0.019
21	0.02	0.03
24	0.024	0.022
27	0.027	0.024
30	0.03	0.04

Table: 6 Comparison of Theoretical and measured values of void ratio at Different Depth

Depth (m)	Theoretical Values	Measured values
3	0.2	0.22
6	0.27	0.25
9	0.35	0.37
12	0.42	0.45

15	0.5	0.48
18	0.57	0.56
21	0.65	0.66
24	0.72	0.73
27	0.8	0.78
30	0.87	0.85

Table: 7 Comparison of Theoretical and measured values of void ratio at Different Depth

Depth (m)	Theoretical Values	Measured values
3	0.43	0.42
6	0.45	0.46
9	0.46	0.45
12	0.47	0.47
15	0.48	0.49
18	0.49	0.48
21	0.51	0.52
24	0.52	0.53
27	0.53	0.51
30	0.55	0.56

Table: 8 Comparison of Theoretical and measured values of void ratio at Different Depth

Depth (m)	Theoretical Values	Measured values
3	0.43	0.45
6	0.41	0.43
9	0.37	0.39
12	0.33	0.31
15	0.29	0.31
18	0.26	0.24
21	0.25	0.23
24	0.27	0.26
27	0.54	0.56
30	0.46	0.44

Table: 9 Comparison of Theoretical and measured values of void ratio at Different Depth

Depth (m)	Theoretical Values	Measured values
3	0.4	0.38

6	0.35	0.36
9	0.3	0.29
12	0.25	0.24
15	0.21	0.19
18	0.17	0.18
21	0.14	0.16
24	0.12	0.11
27	0.12	0.1
30	0.12	0.11

Table: 10 Comparison of Theoretical and measured values of void ratio at Different Depth

Depth (m)	Theoretical Values	Measured values
3	0.35	0.37
6	0.27	0.26
9	0.21	0.23
12	0.16	0.18
15	0.14	0.14
18	0.13	0.15
21	0.14	0.16
24	0.16	0.18
27	0.21	0.24
30	0.27	0.29

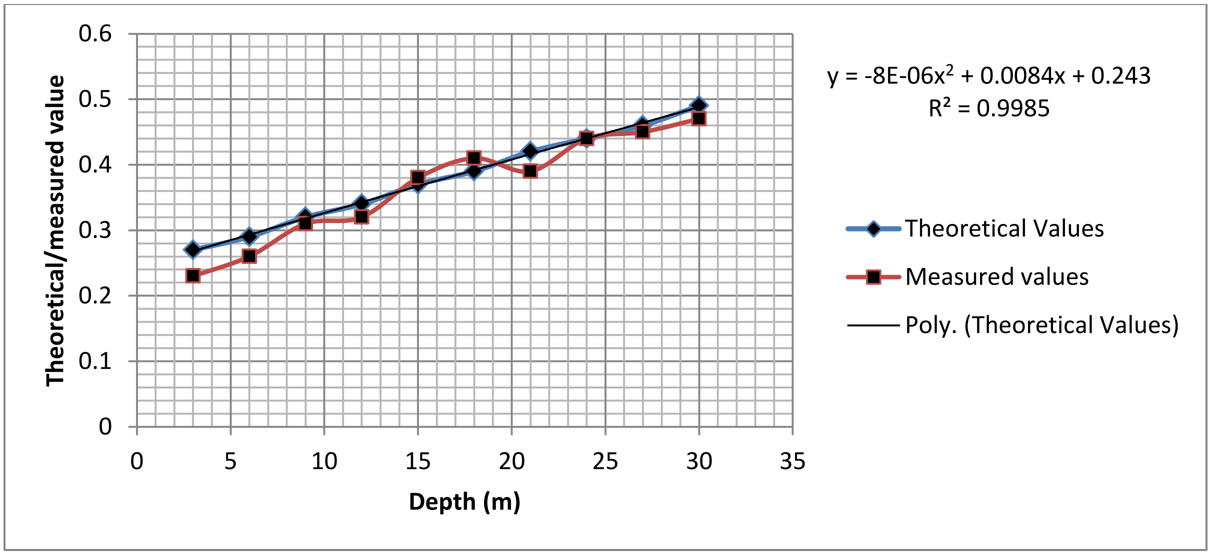

Figure: 1 Comparison of Theoretical and measured values of void ratio at Different Depth

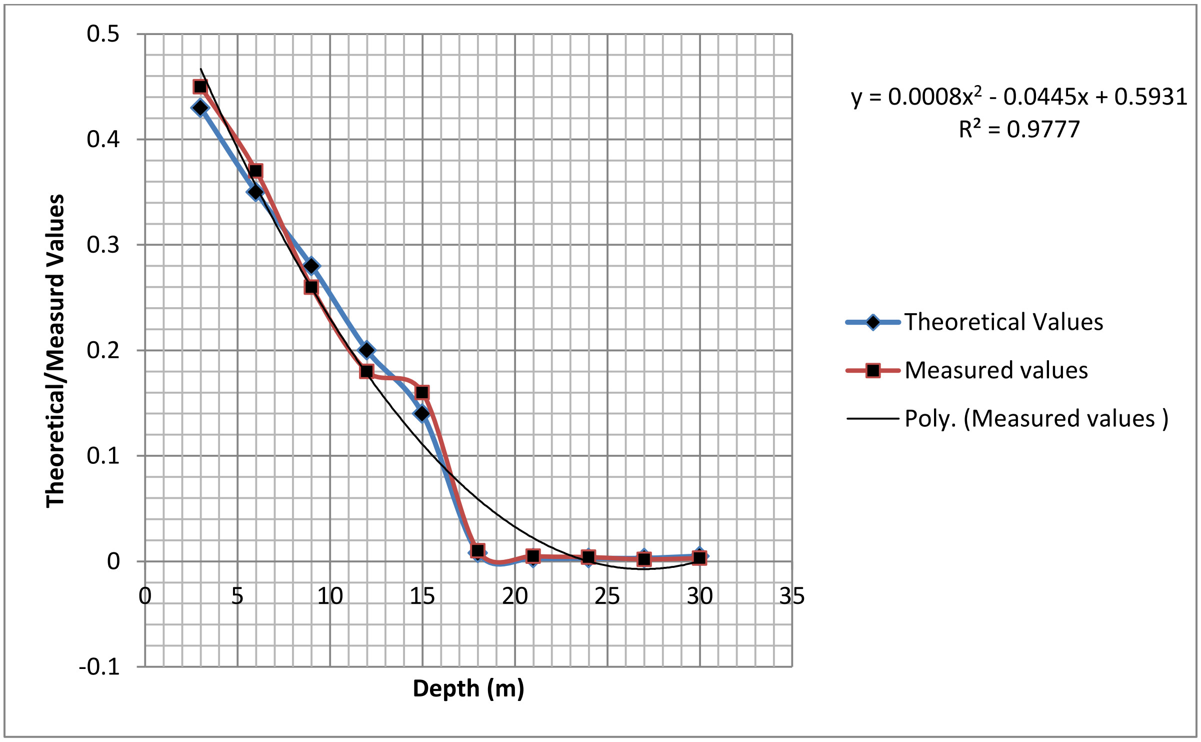

Figure: 2 Comparison of Theoretical and measured values of void ratio at Different Depth

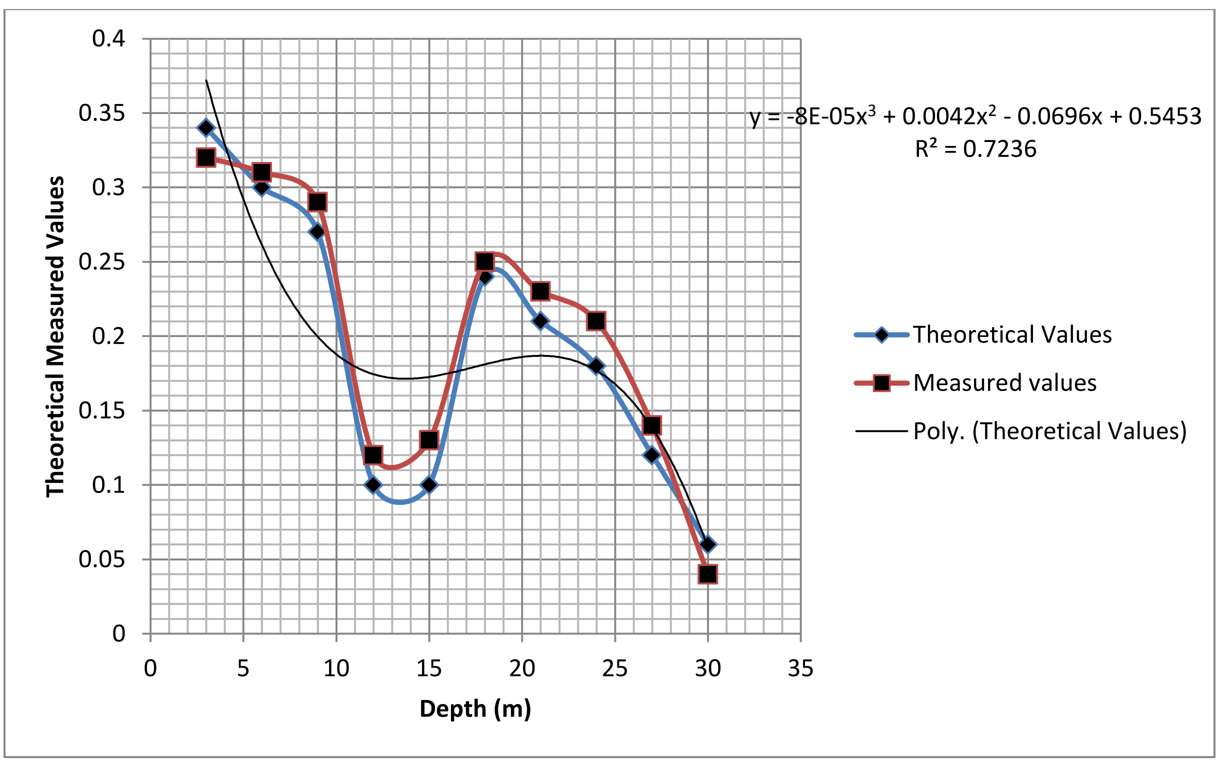

Figure: 3 Comparison of Theoretical and measured values of void ratio at Different Depth

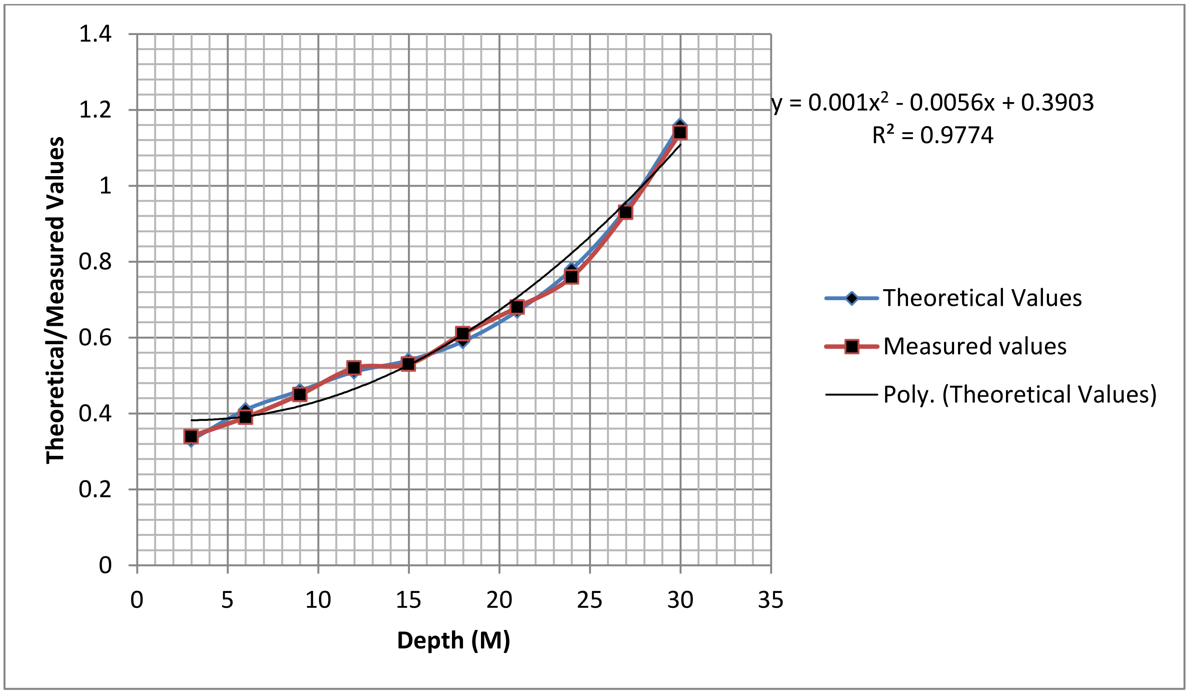

Figure: 4 Comparison of Theoretical and measured values of void ratio at Different Depth

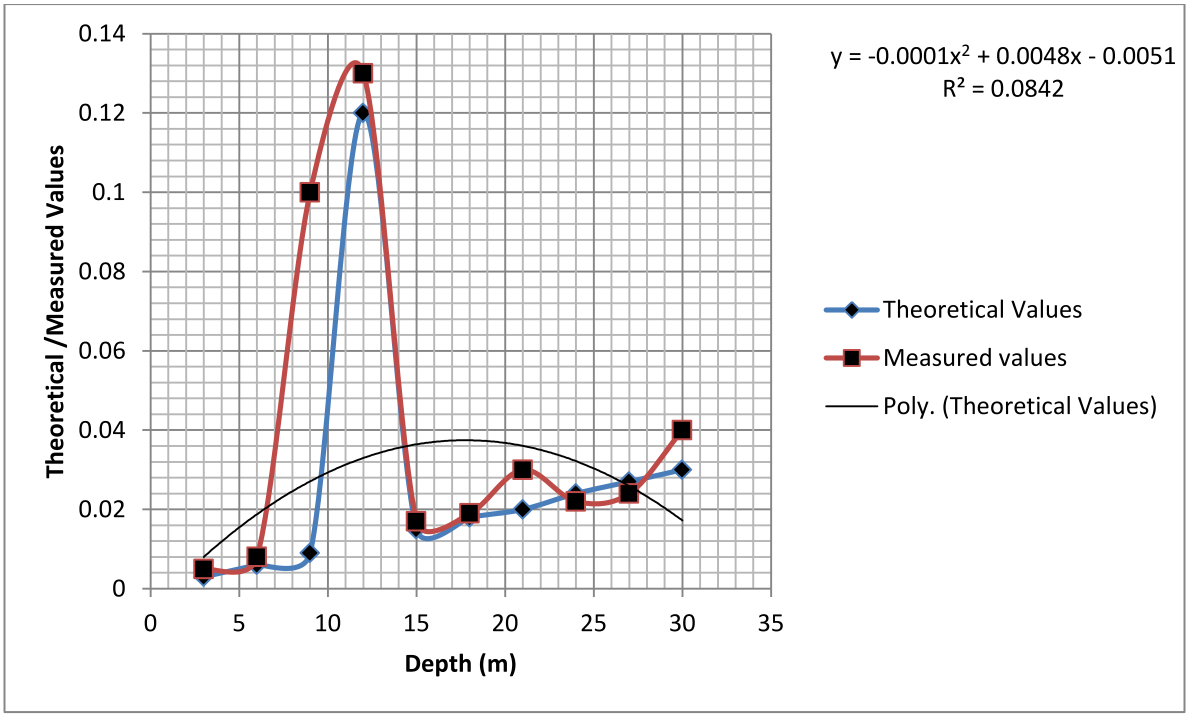

Figure: 5 Comparison of Theoretical and measured values of void ratio at Different Depth

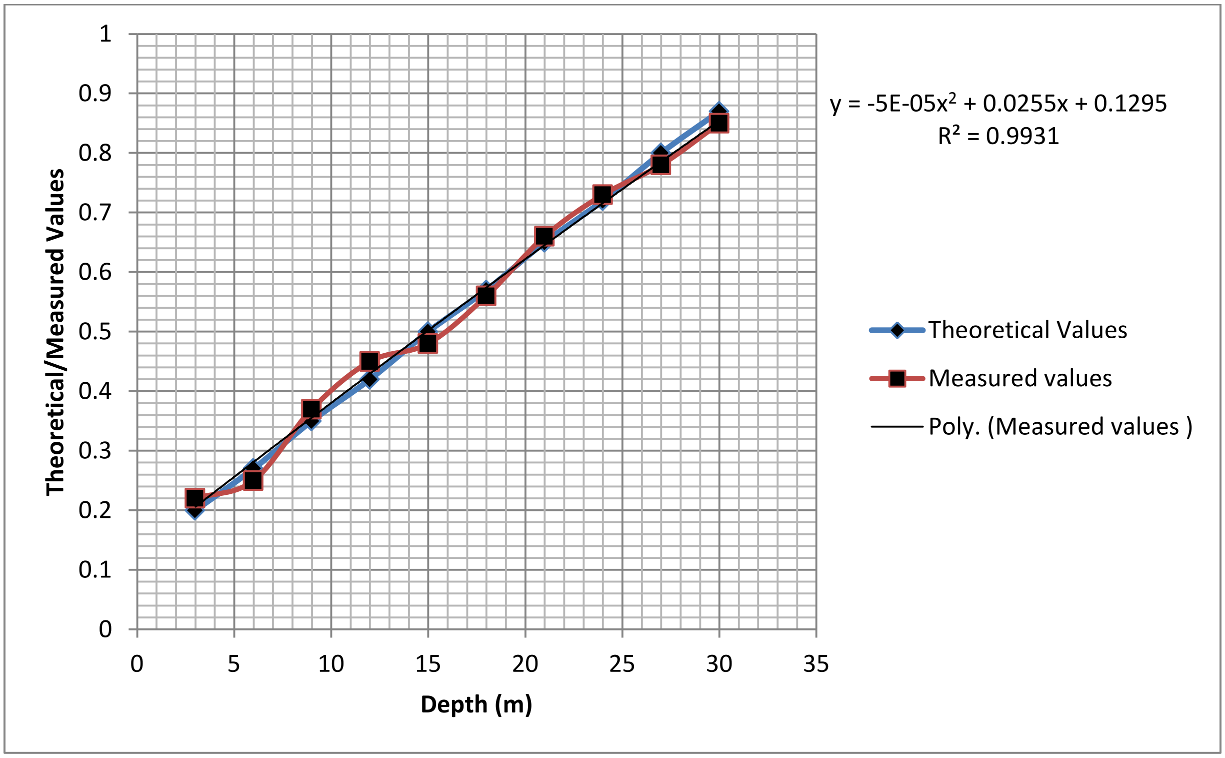

Figure: 6 Comparison of Theoretical and measured values of void ratio at Different Depth

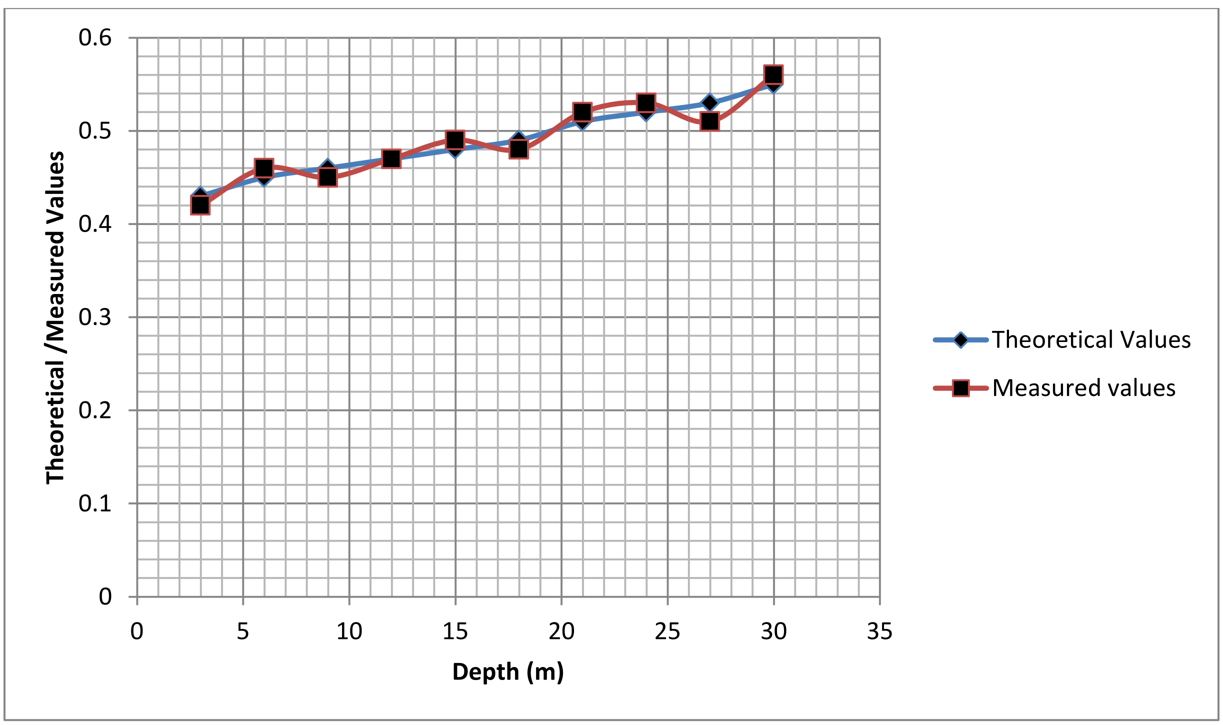

Figure: 7 Comparison of Theoretical and measured values of void ratio at Different Depth

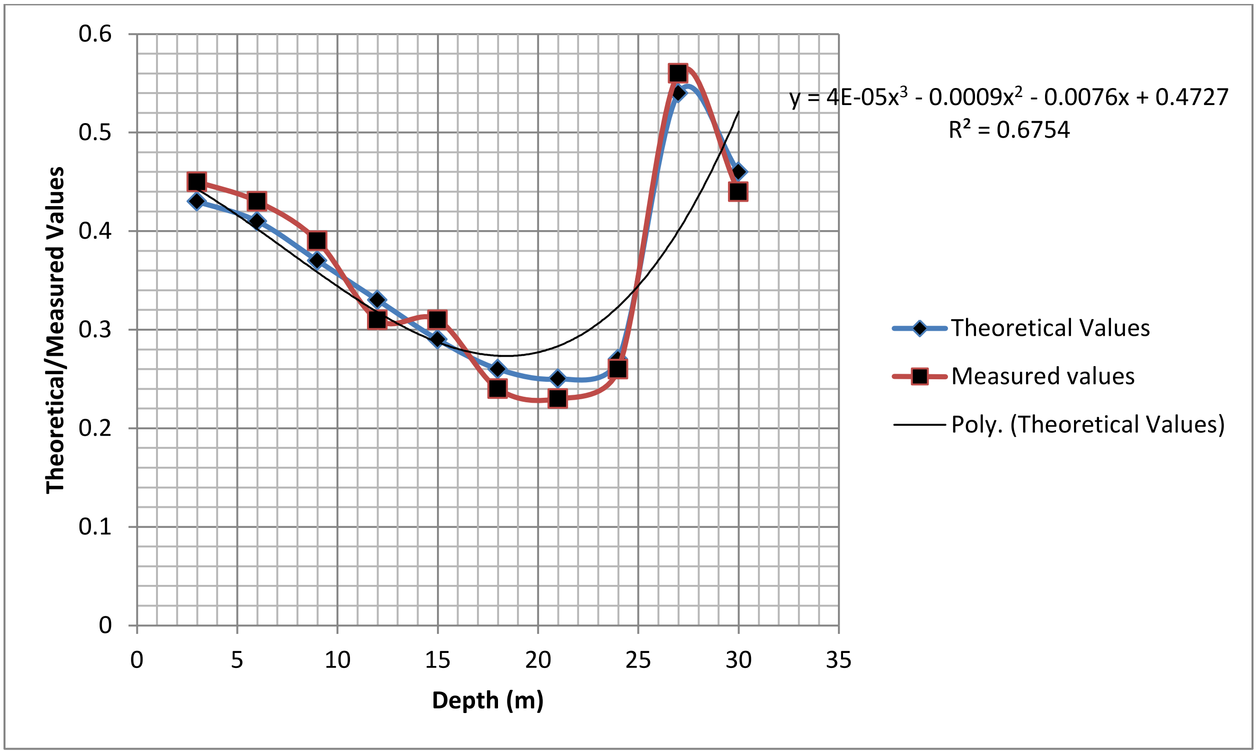

Figure: 8 Comparison of Theoretical and measured values of void ratio at Different Depth

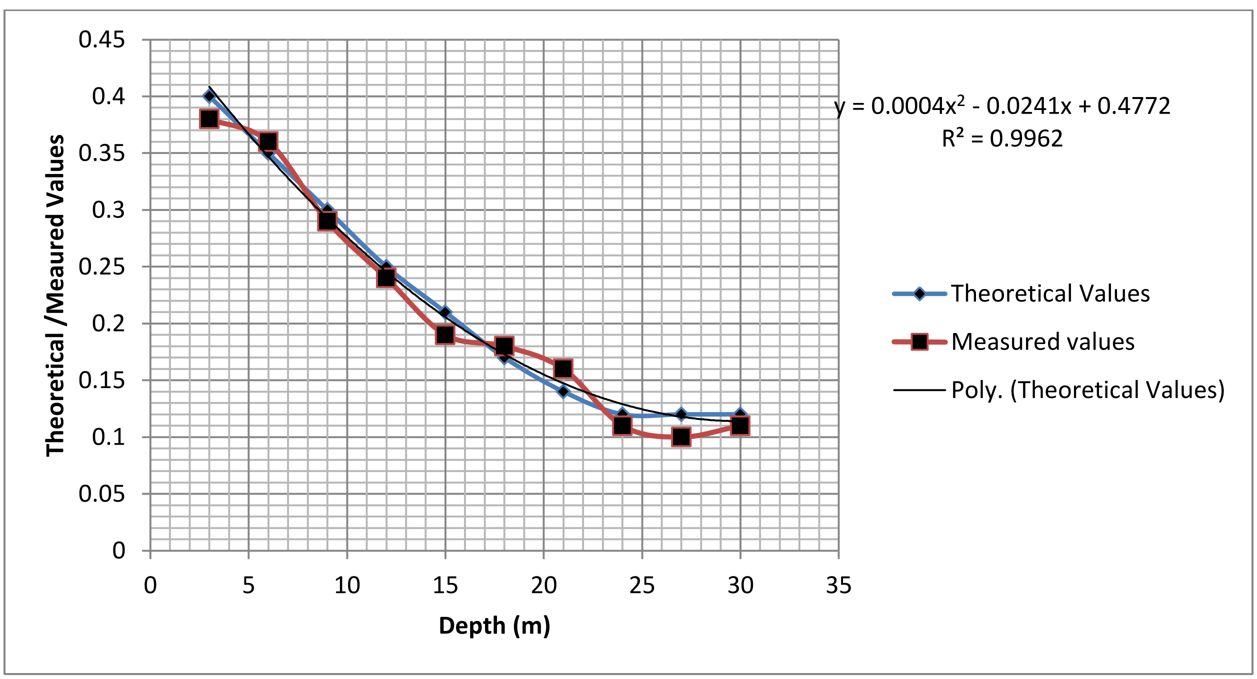

Figure: 9 Comparison of Theoretical and measured values of void ratio at Different Depth

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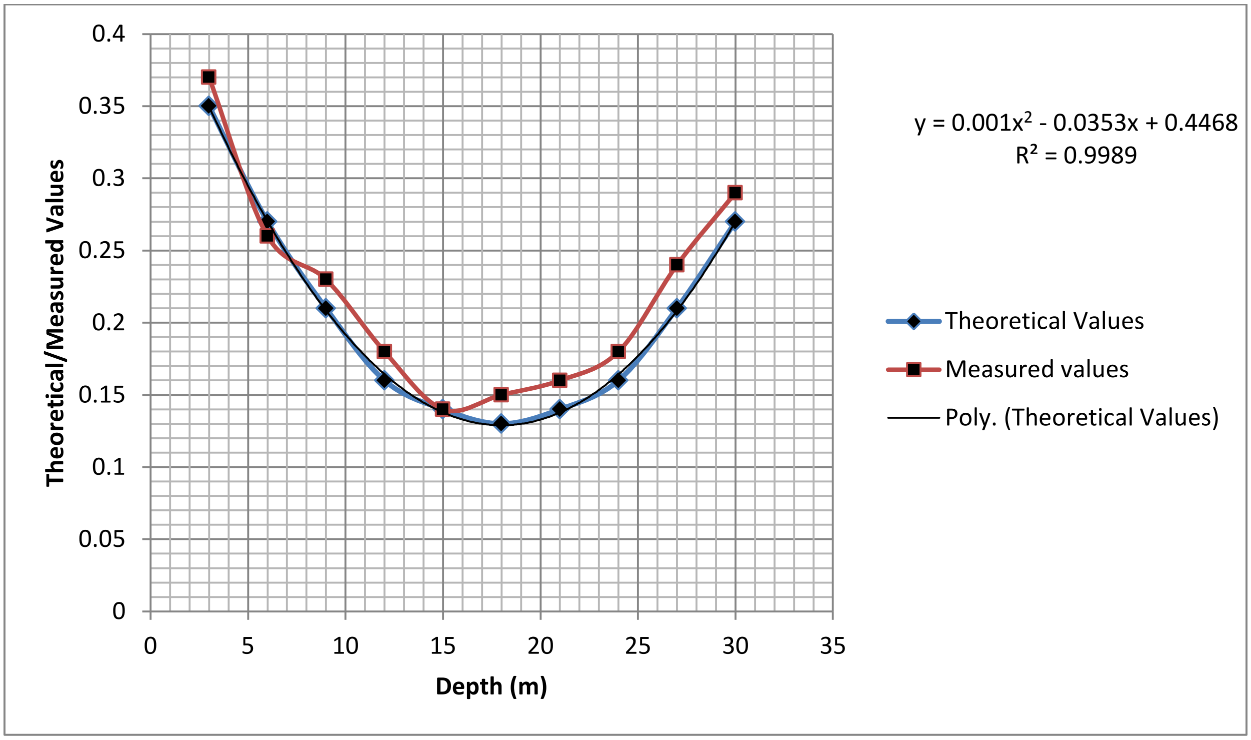

Figure: 10 Comparison of Theoretical and measured values of void ratio at Different Depth

Figure 1 shows that the theoretical values increase with depth linearly and obtained its optimum values at thirty metres, while the measured value maintained the same condition, but with slight fluctuation at the same optimum distance of thirty metres. Figure 2 shows that the theoretical values increase at three metres and gradually decrease with increase in depth to the lowest between eighteen to thirty metres. Similarly, the measured values also obtained the degree of deposition. Figure 3 theoretical and measured values optimum deposited at three metres and suddenly decrease with depth between twelve and fifteen metres fluctuating down to where the lowest degree of void ratio were obtained at thirty metres. Figure 4 both parameters established its highest degree of void ratio at three and gradually increase with depth to the point were the optimum values were obtained. Figure 5 theoretical and measured value establishes a rapid increase from three metres to nine metres and suddenly decreased with depth, fluctuating down to the lowest degree of void ratio with a slight increase at thirty metres. Figure 6 and 7 gradually increase with depth to the optimum values at thirty metres to be the highest degree of both parameters gradually increases in depth to the optimum values at thirty metres, the lowest degrees were recorded at three metres. Figure 8 theoretical and measured values developed an increase at thirty metres and suddenly fluctuate between eighteen and twenty seven metres, the optimum values of highest degrees of void ratio were recorded, but finally developed slight decrease at thirty metres. Figure 9 of both parameters developed its optimum value where the lowest degree were obtained and finally decreased with depth to the point were the highest degrees of void ratio were recorded at thirty metres. Figure 10 of theoretical and measured developed its optimum values at three metres and it gradually decrease with depth, down to fifteen metres; suddenly develop an increase from fifteen to thirty metres. Both parameters compared favourably well. The condition has explained the degree of micropore in soil structure at different depth, the predictive model compared favourably well with the measured values, it shows the authenticity on the predictive model. Validating this model values with other values at different study locations, shows that the predictive model can be applied to determine the rate of hydraulic conductivity at homogeneous formation in upland area of Rivers State. The rate of hydraulic conductivity of flow in soil structure influenced the rate of microbial migration to ground water aquifer, the predictive model comparing favourably well with other location results also implies that the model values can be applied in design construction and management of ground water quality in upland area of Rivers State.

4. Conclusion

From every point of indication it is clear that the predictive model has detail the soil structure at every depth, including the formation deposition and its influence from the micropore as deposited in the study location. The rate of homogeneous deposition in the study location explained the rate of hydraulic conductivity at various depths; it has also detailed the rate of microbial transport influence by the level of homogeneous deposition in upland area of Rivers State. The study is imperative because the rate of hydraulic conductivity and the rate of influence of the micropore of the soil deposition have been investigated and predictive model developed is to investigate solute transport of microbes and its rate of deposition within a short period of time in the study area.

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