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Research article

VOID RATIO AND POROSITY VALIDATION OF E.COLI MIGRATION ON HOMOGENOUS AQUIFER IN UPLAND AREA OF RIVER STATE, NIGERIA

Eluozo. S. N

Department of Civil Engineering, Faculty of Engineering, University of Nigeria Nsukka.
E-mail: solomoneluozo2000@yahoo.com

Abstract

This study has assessed the rate of microbial migration to ground water aquifer in the upland area of Rivers State. The stratification of the formation was confirmed to be homogenous, void ratio and porosity was determined through a thorough laboratory experiment for ten locations. Insitu method of sample collection from a borehole drilling site was applied in upland area of Rivers State, porosity and void ratio are known to be the major influence of microbial transport, base on the stratification influenced by the geological formation of the study area. The influences were observed from high degree of deposition of void ratio and porosity, these low degrees were found fluctuating at shallow depth between twelve and twenty metres. Three and twelve metres for seven locations are high degree of both parameters between the stated figures, while fifteen to thirty metres for three locations. This condition shows that the microbial transport in most parts of upland area may experience low migration as compared to coastal area of Rivers State. the study is imperative because it has confirmed different migration between the coastal and upland area of Rivers State, the study has developed avenue or platform for Engineers and scientist including technician to understand variation of contamination from microbes, it will definitely be a benchmark for professionals in quality groundwater management to avoid water pollution for human consumption in the study area.

Keywords: Rivers, groundwater, E.coli,

1. Introduction

Porosity and void ratio is a major influence in the migration E.coli to ground water aquifer, the study area are also influenced by other deposition from the stratification of the soil structures, the condition varies in most part of the world, the formation of Rivers state is influenced by the predominant deltaic environment, the geologic history from the deltaic environment make up the deposition that influence ground water aquifer in the study location, the behaviour of microbial transport E.coli is influenced by the depositions of the formation. The Riverine area of the Niger Delta is a coastal belt of swamps bordering the Atlantic Ocean the swamps are vegetated tidal flats formed by a reticulate pattern of interconnected meandering creeks and distributaries of the River Niger. The forests are of two types: nearest the sea is a belt of saline brackish mangrove swamp separated from the sea by sand beach ridges (except west of Benin River). Within the mangrove swamp forest numerous sandy islands occur with fresh water vegetation (Allen, 1965; 1970; Nedeco, 1961; Weber, 1971). Fresh water swamps gradually supersede the mangroves on the landward side. About 70% of Nigeria's crude oil and gas production is from this area. The riverine area is home to a large population living mainly in small villages scattered along the banks of rivers and creeks. Rainfall in this coastal belt is heavy varying from 2400 to 4000 mm annually. One of the most serious problems of the region concerns the availability of fresh water. Inhabitants of sandy beach ridges, river point bars or islands obtain fresh water from shallow wells or earth pits. However, most of the people depend on rainwater collected during the rainy season; but this hardly suffices in the dry season. The alternative lies in the development of groundwater. Fresh water occurs in shallow unconfined aquifers, in sands of the coastal beach ridges and river point bars, as well as in sandy islands within the mangrove belt. It also occurs in confined aquifers at varying depths. Drilling for water in the coastal belt has been carried out by both federal and state governments. These boreholes were drilled without detailed hydrogeological studies, resulting in a large number of the wells having brackish water. of Nigeria Ltd drilled boreholes into the deep confined aquifers to obtain fresh water (samples 4 and 6), while samples 10 and 11 represent surface water in the mangrove belt area.

The geology and geomorphology of the Niger-Delta have been described by various authors: (Allen 1965; Akpokodje 1979 and 1987; Assez 1970 and 1976; Avbovbo 1970; Oomkens 1974; Burke 1972; Rement 1965; Short and Stauble 1967; Hospers 1965; Ejadiavwe 1981; Evany et al 1979; Effeotor and Akpokodje 1990; Maron 1969 and Kogbe and Assez 1979. When rain falls to the ground, the water does not stop moving. Some of it flows along the surface in streams or lakes, plants use some while some evaporates and returns to the atmosphere others sink into the ground. Imagine putting a glass of water onto a pile of sand. Where does the water go? The water moves into the spaces between the particles of sand. Groundwater therefore, is that which exist below the earth surface, within saturated layers of sand, gravel and pore-spaces in sedimentary or crystalline rocks, while freshwater is the water from the zone that is not invaded. (Tyson, 1993). When more rainfall occurs, the solute penetrates the soil deeper and this percolates the water table. During percolation, the water leaches the buried pipes, waste materials from the gas plant Industries, Factories and washes down the spilled oil into the soil thereby becoming part of the flow system immediately it gets to the water table. (Oseji et al 2005, 2010; Oyedele, 2001 and Wilson, 1990). The depth to water table can be determined by digging a hole progressively deeper into the ground, the depth at which water begins to seep into the hole indicate that the surrounding material is saturated with water and this mark the height of the local water where there is no surface water, (Buddemeier and Schloss, 2000). Groundwater flow is very slow compared to surface water movement. However, Groundwater, like surface water, flows 'downhill' in the direction determined by the slope of the water table. Groundwater flow is therefore, from high hydraulic head [high water level] to low hydraulic head [low water level]. (Buddemeier and Schloss, 2000: Oseji 2010). The area under study is underlain by Benin Formation, one of the Tertiary-Recent sediments of the Niger Delta. This formation had earlier been referred to as the coastal plain sands (Simpson, 1955) and was renamed the Benin Formation (Reyment, 1965). The of the depth of shallow water depositional medium (Asseez, 1976). The otherwise continuous body of the Benin Formation is interrupted by the Afam Clay member who consists mainly of clay with few intercalations of sandstone bodies. The Formation consists generally of lenticular unconsolidated, friable Benin Formation is one of the major aquiferous formations in Imo – Kwa Iboe River Basins (Offodile, 2000). In the southward part, the Benin Formation appears to be in hydrogeological contact with the Ameki and the alluvial deposits of the Niger River and hence provide combined aquiferous horizons (Offodile, 2000: Gordon et al 2012).). The Formation outcrops in the northeast of the coastal belt and dips at the low angle, in the southeast. The sediments consist generally of lenticular, unconsolidated dominantly sandy formations. Pebble beds occur in places and have given rise to high yielding boreholes e.g in Port Harcourt. The sand –shale intercalations in the formation suggest a multi-aquifer system. The first aquifer is unconfined and generally exists almost throughout the coastal area. Depth to water table ranges from 2-15m. Lenticular clays and shales occur particularly in the eastern areas where they comprise small but moderately high yielding aquifers e.g. Calabar, Uyo and some of them gave rise to artisan wells. Recharge is in most cases direct by precipitation through the generally copious permeable sands of the Benin Formation (Gordon et al 2012).

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 thorough analysis for void ratio and porosity, the experiment performed for the two parameters were determine the rate of influence on this two parameters for microbial transport to ground water aquifers on alluvium deposition.

3. Results and Discussion

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

Table 1: Void ratio and porosity deposition at various depth

Distance	void Ratio location 1	POROSITY (N)
3	0.33	0.66
6	0.22	0.44

9	0.25	0.5
12	0.29	0.58
15	0.98	0.04
18	0.12	0.28
21	0.14	0.7
24	0.35	0.7
27	0.98	0.6
30	0.32	0.06

Table 1: Void ratio and porosity deposition at various depth

Distance	void Ratio location 2	POROSITY (N)
3	0.41	0.82
6	0.31	0.62
9	0.56	1.12
12	0.06	0.12
15	0.07	0.14
18	0.19	0.38
21	0.04	0.08
24	0.06	0.12
27	0.00098	0.0013
30	0.09	0.18

Table 2: Void ratio and porosity deposition at various depth

Distance	void Ratio location 3	POROSITY (N)
3	0.29	0.58
6	0.34	0.68
9	0.33	0.66
12	0.23	0.46
15	0.27	0.54

18	0.14	0.28
21	0.1	0.08
24	0.12	0.12
27	0.11	0.0013
30	0.07	0.18

Table 3: Void ratio and porosity deposition at various depth

Distance	void Ratio location 4	POROSITY (N)
3	0.31	0.62
6	0.41	0.8
9	0.38	0.76
12	0.33	0.72
15	0.16	0.32
18	0.2	0.44
21	0.2	0.4
24	0.02	0.04
27	0.98	0.02
30	0.015	0.02

Table 4: Void ratio and porosity deposition at various depth

Distance	void Ratio location 5	POROSITY (N)
3	0.09	0.14
6	0.1	0.2
9	0.07	0.14
12	0.15	0.08
15	0.13	0.24
18	0.12	0.26
21	0.24	0.3
24	0.36	0.24
27	0.49	0.1
30	0.57	0.012

Table 5: Void ratio and porosity deposition at various depth

Distance	void Ratio location 6	POROSITY (N)
3	0.19	0.38
6	0.25	0.5
9	0.38	0.676
12	0.13	0.12
15	0.11	0.22
18	0.15	0.3
21	0.99	0.18
24	0.44	0.08
27	0.1	0.2
30	0.08	0.16

Table 6: Void ratio and porosity deposition at various depth

Distance	void Ratio location 7	POROSITY (N)
3	0.2	0.38
6	0.72	1. 42
9	0.62	1.24
12	0.24	0.48
15	0.24	0.72
18	0.36	0.62
21	0.31	0.62
24	0.26	0.52
27	0.05	0.06
30	0.15	0.0037

Table 7: Void ratio and porosity deposition at various depth

Distance	void Ratio location 8	POROSITY (N)
3	0.41	0.82
6	0.44	0.88
9	0.42	0.84
12	0.24	0.48

15	0.24	0.36
18	0.14	0.28
21	0.11	0.26
24	0.06	0.22
27	0.14	0.12
30	0.12	0.28

Table 8: Void ratio and porosity deposition at various depth

Distance	void Ratio location 9	POROSITY (N)
3	0.37	0.74
6	0.37	0.74
9	0.37	0.74
12	0.18	0.36
15	0.2	0.4
18	0.15	0.3
21	0.11	0.22
24	0.07	0.14
27	0.0047	0.0082
30	0.09	0.18

Table 9: Void ratio and porosity deposition at various depth

Distance	void Ratio location 10	POROSITY (N)
3	0.35	0.7
6	0.3	0.6
9	0.27	0.54
12	0.09	0.18
15	0.19	0.38
18	0.05	0.1
21	0.17	0.34
24	0.3	0.72
27	0.44	0.88

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30	0.42	0.84

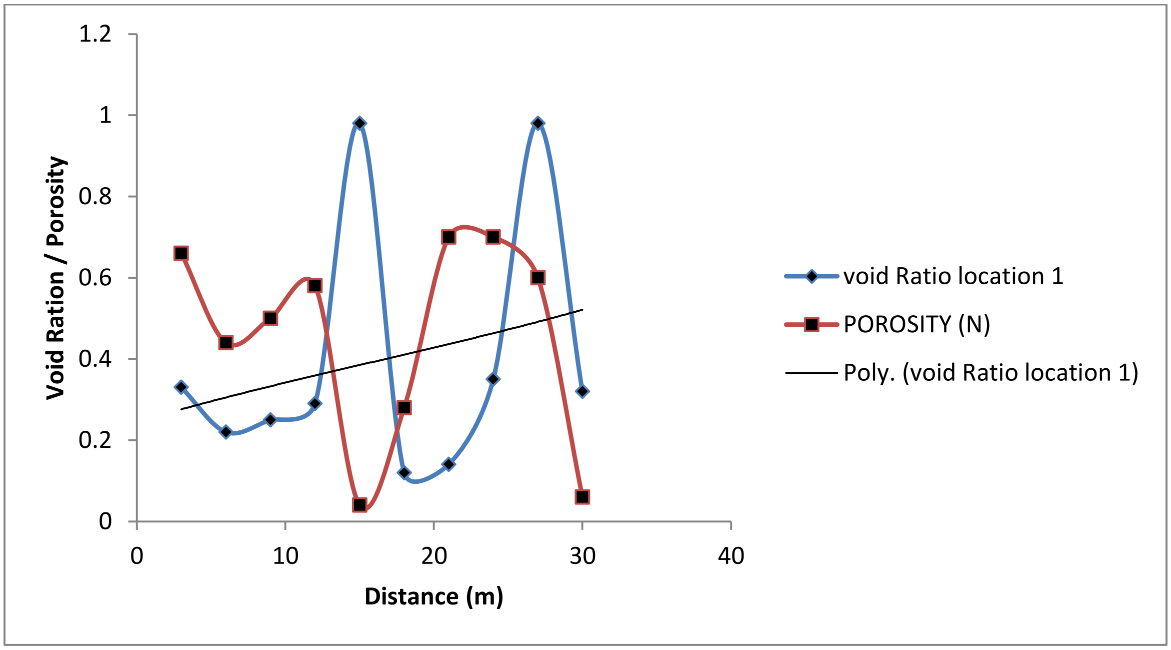

Figure 1: Void ratio and porosity deposition at various Depth

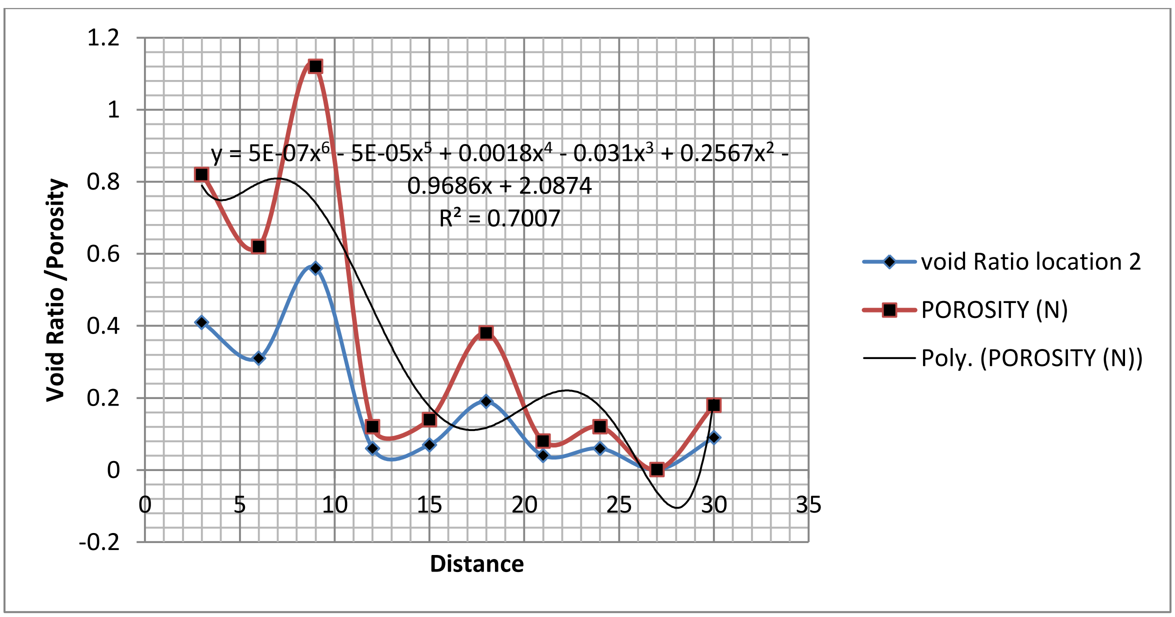

Figure 2: Void ratio and porosity deposition at various Depth

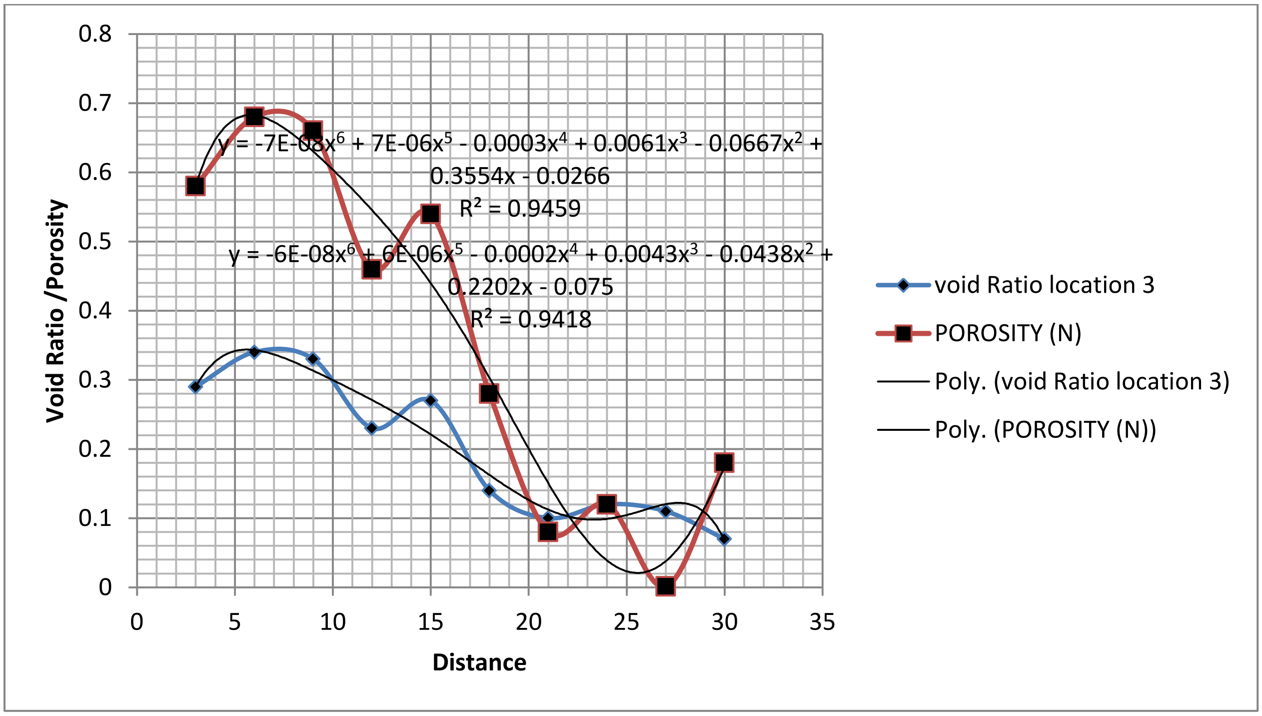

Figure 3: Void ratio and porosity deposition at various Depth

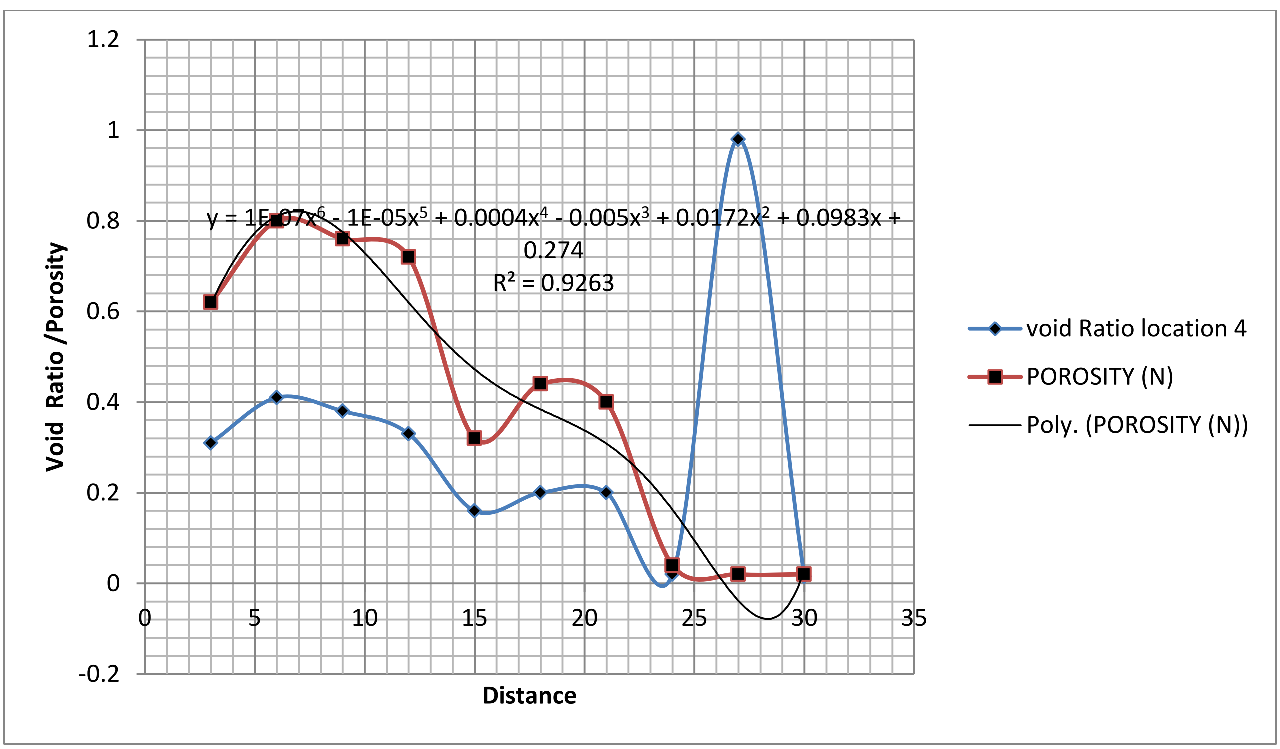

Figure 4: Void ratio and porosity deposition at various Depths

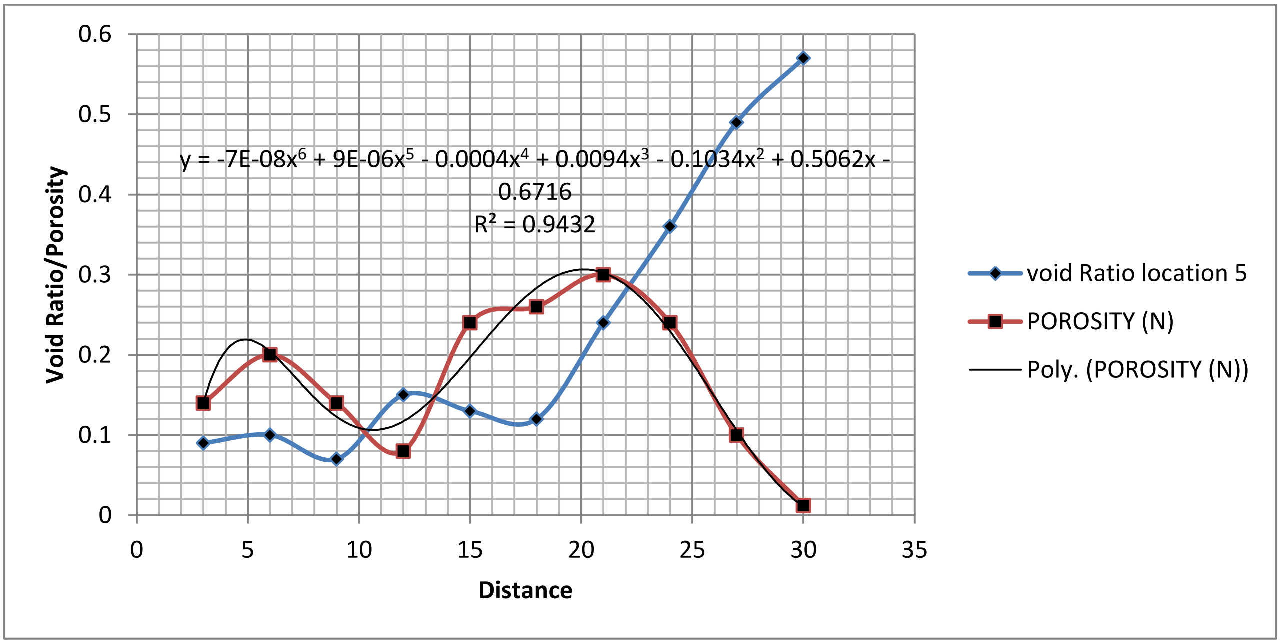

Figure 5: Void ratio and porosity deposition at various Depths

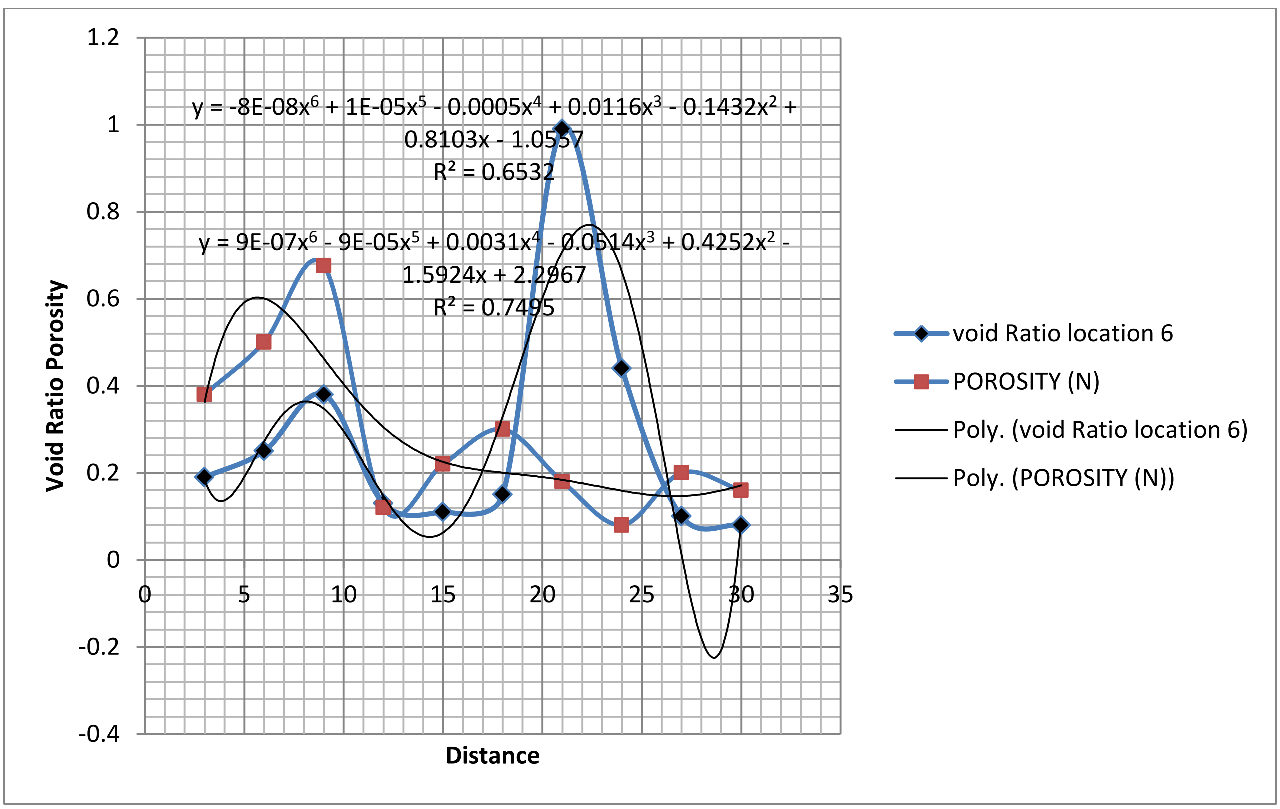

Figure 6: Void ratio and porosity deposition at various Depths

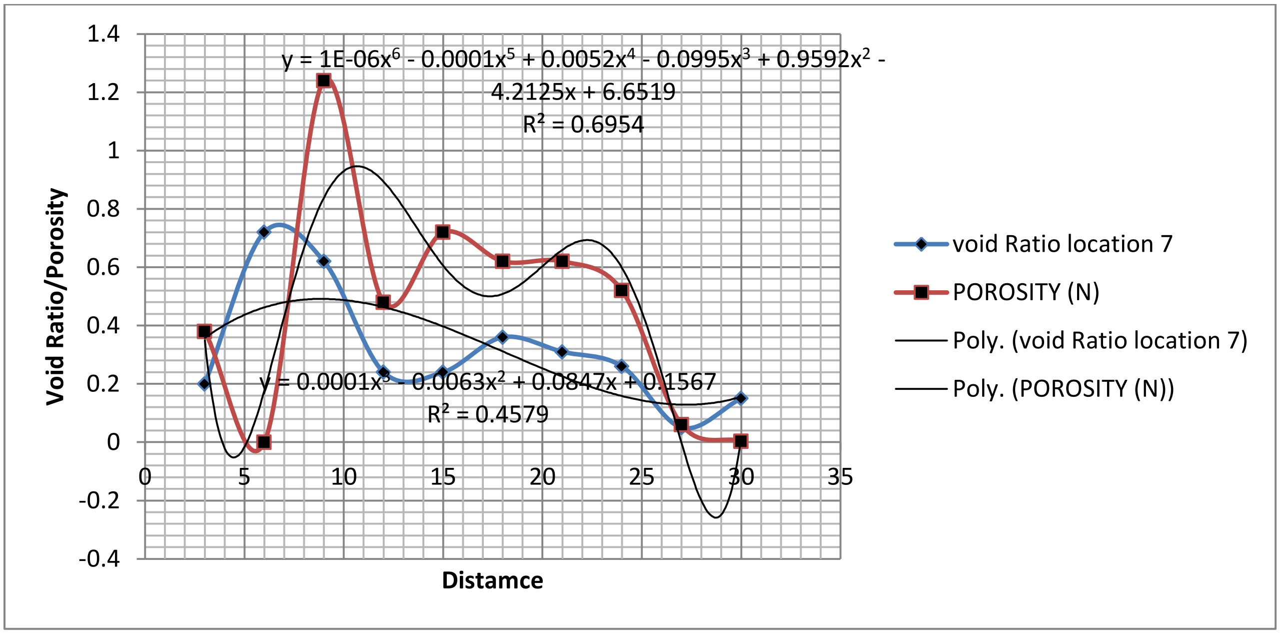

Figure 7: Void ratio and porosity deposition at various Depths

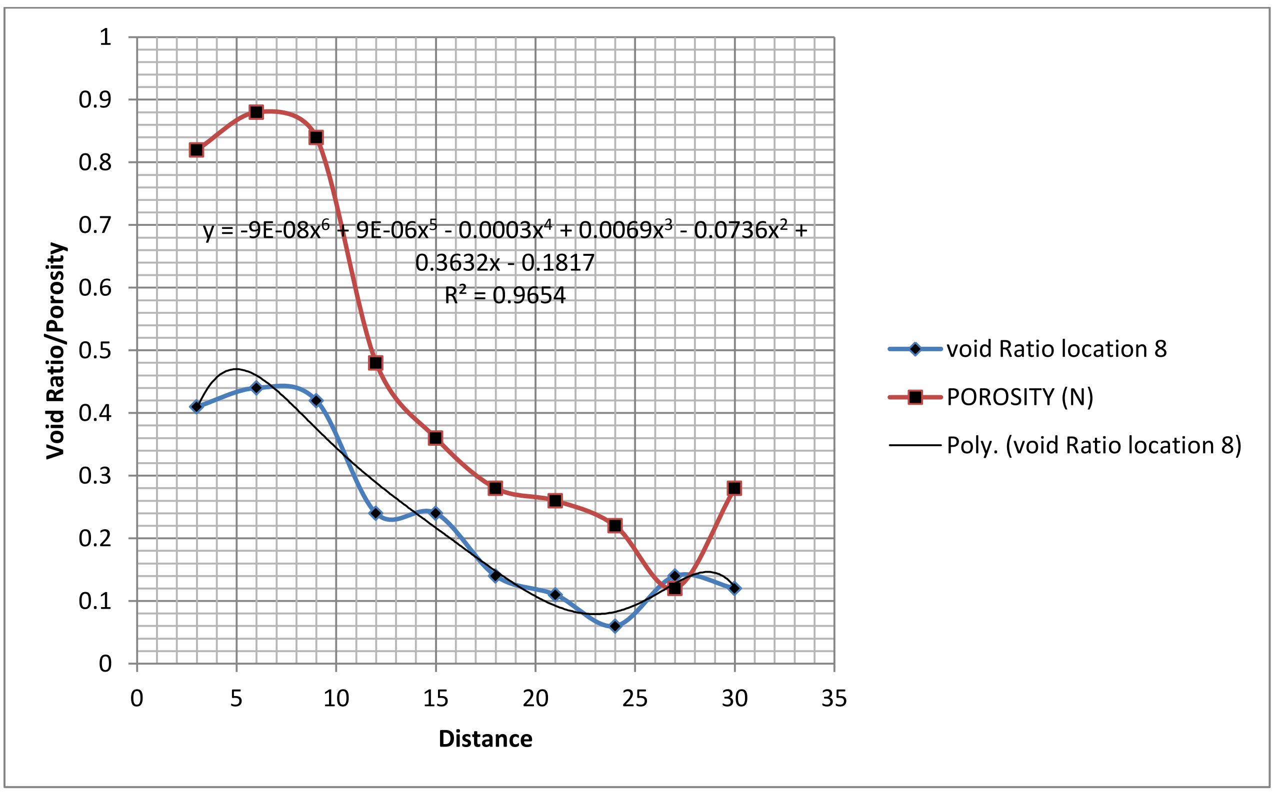

Figure 8: Void ratio and porosity deposition at various Depths

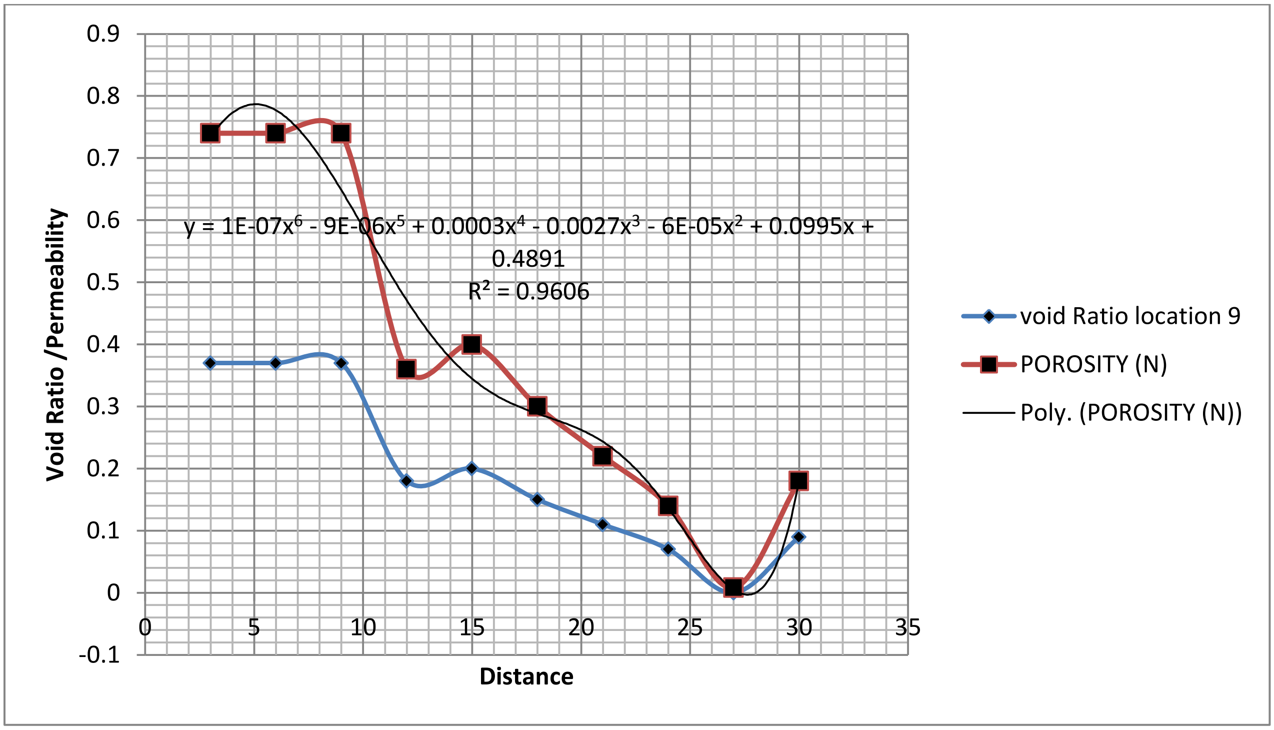

Figure 9: Void ratio and porosity deposition at various Depths

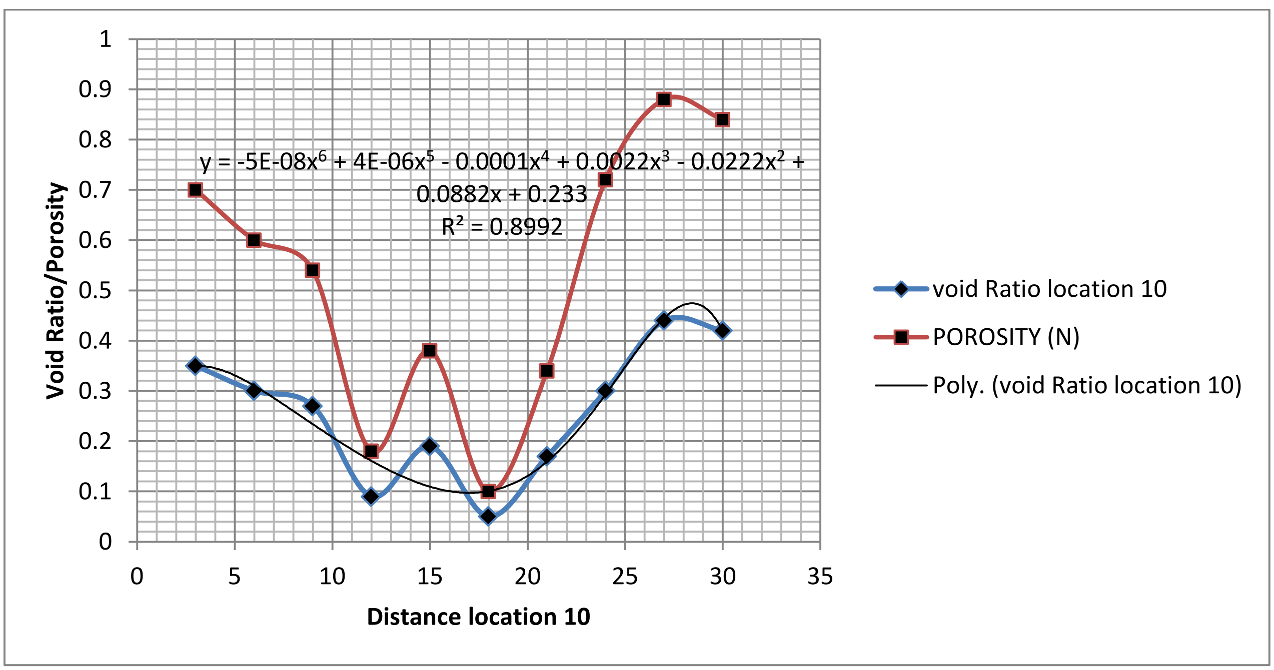

Figure 10: Void ratio and porosity deposition at various Depths

Figure 1 shows that void ratio in a fluctuation form increased with distance to a point where the optimum value were recorded at fifteen metres and suddenly decrease maintaining fluctuation down to the point were the lowest void were recorded at thirty metres, while that of porosity produced its optimum degree of porosity in the same form, but its optimum value were deposited at twenty-one metres and finally decrease with distance to the lowest degree of porosity at thirty metres. Figure 2 produced an oscillation form and also obtained its optimum values at nine metres, it suddenly decreased with distance and fluctuated down to the lowest degree of void ratio at thirty metres. Similarly, porosity developed the same fluctuation in its deposition; it developed its optimum value at the same nine metres simultaneously fluctuating down the lowest degree of porosity also at thirty metres. Figure 3 both parameters produced its optimum values at six metres fluctuating down to the lowest degree of porosity at thirty metres. Figure 4 produced oscillation form in deposition with increase in distance to a point where the optimum is obtained at twenty-seven metres. It suddenly decreased from twenty-seven to thirty metres. While porosity results produced a similarity results and obtained its optimum at six metres and finally maintained the same pace to the point were the lowest degree of porosity from twenty-seven to thirty metres were recorded. Figure 5 produced lowest in void ratio with increase in distance and obtained its optimum at thirty metres, while the porosity gradually increased and optimum were observed at twenty-one and suddenly decrease to the point where the lowest degree of porosity were recorded at thirty metres. Figure 6 experienced an increase from zero to nine metres suddenly fluctuates to the point where an optimum level were recorded at twenty-one metres and finally decreased with distance increase from twenty-four to thirty metres where the lowest degree of void ratio were recorded while porosity maintained similar condition, fluctuating to where the optimum values were observed at nine metres and finally fluctuates down to the lowest degree of porosity that were recorded at twenty-seven metres with slight increase at thirty metres. Figure 7 developed a slight increase and gradually decrease to the lowest level at six metres, a suddenly an increase was observed, where the optimum values were recorded at nine metres, fluctuating down to where the highest degree of void ratio were recorded with distance increase at thirty metres. And porosity gradually increases and experiences its optimum value at six metres and finally fluctuating down with distance increase at thirty metres. Figure 8 developed a fast increase from zero to six metres gradually decreasing with distance increase down to thirty metres where the lowest degree of void ratio was recorded at twenty-seven metres with a slight increase at thirty metres. While porosity results developed an optimum value at six metres oscillating down to the lowest degree with distance increase at twenty-four metres developing a slight increase from twenty to thirty metres. Figure 9 maintained the same level of increase where the highest metres produced its optimum with those values. It experienced sudden decrease with distance, increased by fluctuating from twelve metres to where the lowest degree of void was observed at twenty-four metres. Finally developing a slight increase between twenty-seven and thirty metres. Figure 10 increase simultaneously from three to nine gradually decreasing in a fluctuation form from nine to eighteen metres but developed rapid increase to the optimum level at twenty-seven metres, finally decreased slightly at thirty metres. While porosity gradually increases simultaneously from three to nine metres fluctuating from twelve to twenty-one metres, finally, it rapidly increased to the optimum value at twenty-seven also with slight decrease at thirty metres.

4. Conclusion

Homogenous deposition in upland area of Rivers State has produced results on porosity and void ratio, both parameters has a relationship on the stratification from its deposition of the stratum. The degree of porosity developed some variations between three and twelve metres, few locations were observed to have low porosity and void ratio in the study location. This condition implies that the influence of microbes will migrate fast but not to be compared with coastal location. The degree of both parameters was confirmed to develop high degree of porosity and void ratio between fifteen to thirty metres where the aquiferous zone is predominantly deposited. This condition also implies that the transport of microbes may not migrating fast some regions and they die off on the process of migration in some condition, if there is no substrate utilization that it will feed on and increase its microbial population and transport to ground water aquifer. This study is imperative because it has been confirmed that the rate of transport cannot be compared to the coastal location as presented from the study. Therefore, the condition in the upland shows that the microbes may experience high death rate including lag phase more than the deposition of the coastal area in Rivers State.

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