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PREDICTIVE MODEL TO MONITOR THE GROWTH RATE OF MICROELEMENTS IN WASTE DUMP SITE IN OBIOAKPOR, RIVERS STATE OF NIGERIA

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ABSTRACT

Predictive model to monitor the growth rate of micro nutrient in waste dump site has been thoroughly examined, these models were generated from experimental results, and the derived equations produced theoretical values for five locations. The theoretical values were compared with measured values from other locations, both parameters compared favorably well. This implies that the models can be applied to determine the growth rate of micro nutrient deposition in waste dump site, it was confirmed from the study that high degree of concentration where found to deposit at thirty meters, this implies that without any inhibition there will be high concentration of microbial contaminants in shallow aquifers. The study is imperative because microbial species (E. coli) are predominant in deltaic environment based on the influence of high degree of porosity in the study location. It is recommended that the model should be applied to monitor the growth rate of micro nutrient in the study location; this will serve as a base line for microbial pollution prevention in ground water aquifers.

Keyword

Poultry,Lakes Eucha,Micronutrient Phosphorus,predictive model,microbial species.

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1. Introduction

The collision of improved nutrient loadings on surface waters has drawn considerable attention in recent years. contaminated drinking water, too much algal growth, taste and odor issues, and fish kills are only a few of the negative effects that can result from an overload of nutrients. As an example, Lakes Eucha and Spavinaw on Spavinaw Creek in northeast Oklahoma supply more than half of the drinking water for the cities of metropolitan Tulsa, Oklahoma. Due to the overabundance of nutrient loading in the watershed, excess growth of algae has degraded the water quality of the lake. The cost of drinking water treatment and the taste and odor problems have increased significantly in the past decade. While nitrogen is a concern, phosphorous (P) is generally considered the most limiting nutrient. The majority of P loading to the lake in this area comes from surface-applied poultry litter. Of the 48,000 kg/yr of phosphorous entering Lake Eucha, 69% is thought to come from poultry litter application as fertilizer to pasture and crops in

the watershed (Wagner and Woodruff, 1997; Storm et al., 2001, 2002). Poultry is the principal industry in the basin. In the watershed, over 2,000 poultry houses produce approximately 91,700 tons of poultry litter each year, most of which is applied to permanent pastures' is an essential nutrient not only for crops but also for aquatic life. Excessive soil P concentrations can increase potential P transport to surface waters or leaching into the subsurface. This can have serious negative implications. Daniel et al. (1998) found that concentrations of P critical for terrestrial plant growth were an order of magnitude larger than concentrations at which lake eutrophication may occur Subsurface P transport is a less studied and understood transport mechanism compared to transport by overland flow, although abundant studies have reported its occurrence (Andersen and Kronvang, 2006; Hively et al., 2006; Nelson et al., 2005; Kleinman et al., 2004). For example, Andersen and Krovang (2006) modified a P Index to integrate potential P transport pathways of tile drains and leaching in Denmark. Hively et al. (2006) considered transport of total dissolved P (TDP) for both base flow and surface runoff. Nelson et al. (2005) indicated that phosphorus leaching and subsurface transport should be considered when assessing long-term risk of P loss from waste amended soils. Kleinman et al. (2004) noted that the P leaching is a significant, but temporally and spatially variable transport pathway. From research on four grassland soils, Turner and Hunt (1978) documented that subsurface P transfer, primarily in the dissolved form, can occur at concentrations that could cause eutrophication. Other researchers are beginning to emphasize colloidal P transport in the subsurface, as P attaches to small size particles capable of being transported through the soil pore spaces (Headwaiter et al., 2005; Ilg et al., 2005; de Jonge et al., 2004 John 2006).

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1990, at the end of the International Drinking Water Supply and Sanitation Decade, WHO and UNICEF resolute to merge their experience and resources in a Joint Monitoring Programme for Water Supply and Sanitation (JMP). At its beginning, the overall aim of the JMP was to improve planning and agreement of the water supply and sanitation within countries by assisting countries in the monitoring of their drinking-water supply and sanitation sector. This concept, and the associated objectives, evolved over time. The Millennium Declaration in 2000 and the subsequent formulation of targets under the Millennium Development Goals (MDGs) marked a fundamental change. As the official monitoring instrument for progress towards achieving MDG 7 target C, the JMP prepares biennial global updates of this progress. Prior to 2000, JMP assessments had been undertaken in 1991, 1993, 1996 and 2000. The results for the year 2000 survey are presented in *Global water supply and sanitation assessment 2000 report* (WHO/UNICEF, 2000), which contains data for six global regions: Africa, Asia, Europe, Latin America and the Caribbean, Northern America, and Oceania. This report introduced a monitoring approach based on household surveys and censuses which has subsequently been refined. The methods and procedures lead to an estimate of numbers of people with access to improved water sources and improved sanitation. Since the 2000 report, five more JMP reports have been published. The latest, published in March 2010, shows that by the end of 2008 an estimated 884 million people in the world lacked access to improved sources of drinking water and 2.6 billion people lack access to improved sanitation facilities. If the current trend continues, the MDG drinking-water target will be exceeded by 2015, but the sanitation target will be missed by about 1 billion people (over and above the 1.7 billion who would not have access even if the target were achieved). In the past, the JMP drew guidance from a technical advisory.

2. Materials and Method

Experiments were carried out to determine the E.coli, micronutrients, porosity. The results were subjected to polynomial curve fitting. Values of the associated polynomial constants generated were used to establish the empirical models. Column experiments were also

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performed using soil samples from several borehole locations. The soil samples were collected at intervals of three metres each (3m). The micronutrients are Phosphorus. The micronutrients normally influence the levels of microbial growth migrating to ground water aquifer, the theoretical are stated bellow.

Theoretical Background

Theoretical background for 3rd degree polynomial curve fitting

General: $y = a_0 + a_1 x + a_2 x^2 + a_3 x^3 + ... + a_n x^n$

If the above polynomial fits the pair of data (x, y) it means that every pair of data will satisfy the equation (polynomial).

Thus; $y_1 = a_0 + a_1 x_1 + a_2 x_1^2 + a_3 x_1^3 + ... + a_n x_1^n$ ………… (1)

$y_2 = a_0 + a_1 x_2 + a_2 x_2^2 + a_3 x_2^2 + ... + a_n x_2^n \ldots$ ………… (2)

$y_3 = a_0 + a_1 x_3 + a_2 x_3^2 + a_3 x_2^2 + ... + a_n x_2^n$ ………… (3)

$y_4 = a_0 + a_1 x_4 + a_2 x_n^2 + a_3 x_n^2 + ... + a_n x_4^n$ ………… (4)

Summing all the equations will yield $\rightarrow$ (1 n)

$$\sum_{i=1}^{i=n} y_i = \sum a_0 + \sum_{i=1}^{i=n} a_1 x_i + \sum_{i=1}^{i=n} a_2 x_i^2 + \sum_{i=1}^{i=n} a_3 x_i^3 + \sum_{i=1}^{i=n} a_4 x_i^4 + ... + \sum_{i=1}^{i=n} a_n x_i^n$$

$$\boxed{\sum_{i=1}^{i=n} y_i = n a_0 + a_1 \sum_{i=1}^{n} x_i + a_2 \sum_{i=1}^{n} x_i^2 + a_3 \sum_{i=1}^{n} x_i^3 + ... + \sum_{i=1}^{n} x_i^n} \quad ………… (5)$$

To form the equations to solve for the constants $a_0, a_1, a_2, a_3, ...a_n$.

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We multiply equations (3.84) by $x_{i,} \, x_i^2, \, x_i^3 .... \, x_i^n$.

$$\sum_{i=1}^{1} y_i = na_0 + a_1 \sum x_i + a_2 \sum x_i^2 + a_3 \sum x_i^3 + ... + a_n \sum x_i^n \qquad .... \qquad (6)$$

Multiply equation (6) by x_i

$$x_i \sum y_i = na_0 \, x_i + a_1 \, x_i \sum x_i + a_2 \, x_i \sum x_i^2 + a_3 \, x_i \sum x_1^3 + ... + a_n \, x_i \sum x_i^n$$

$$\sum y_i \, x_i = a_0 \sum x_i + a_1 \sum x_i^2 + a_2 \sum x_i^3 + a_3 \sum x_i^4 + ... + a_n \sum x_i^{n+1} \qquad .... \qquad (7)$$

Multiply equation (6) by x_i^2

$$x_i^2 \sum y_i = na_0 \, x_i^2 + a_1 \, x_i^2 \sum x_i + a_2 \, x_i^2 \sum x_i^2 + a_3 \, x_i^2 \sum x_i^3 + ... + a_n \, x_i^2 \sum x_i^n \; .. \qquad (8)$$

$$\sum y_i \, x_i^2 = a_0 \sum x_i^2 + a_1 \sum x_i^3 + a_2 \sum x_i^4 + a_3 \sum x_i^5 + ... + a_n \sum x_i^{n+2} \qquad .... \qquad (9)$$

Multiply equation (3.85) by x_i^3

$$x_i^3 \sum y_i = na_0 \, x_i^3 + a_1 \, x_i^3 \sum x_i + a_2 \, x_i^3 \sum x_i^2 + a_3 \, x_i^3 \sum x_i^3 + ... + a_n \, x_i^3 \sum x_i^n$$

$$\sum y_i \, x_i^3 = a_0 \sum x_i^3 + a_1 \sum x_i^4 + a_2 \sum x_i^5 + a_3 \sum x_i^6 + ... + a_n \sum x_i^{n+3} \qquad .... \qquad (10)$$

Multiply equation (6) by x_i^n

$$x_i^n \sum y_i = a_0 n \, x_i^n + a_1 \, x_i^n \sum x_i + a_2 \, x_i^n \sum x_i^2 + a_3 \, x_i^n \sum x_i^3 + ... + a_n \, x_i^n \sum x_i^n$$

$$= a_0 \sum x_i^n + a_1 \sum x_i^{n+1} + a_2 \sum x_i^{n+2} + a_3 \sum x_i^{n+3} + ... + a_n \sum x_i^{n+n} \qquad .... \quad n$$

Putting equation (6) to n into matrix form

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$$\begin{bmatrix} n & \sum x_i & \sum x_i^2 & \sum x_i^3 & \ldots\ldots \sum x_i^n \\ \sum x_i & \sum x_i^2 & \sum x_i^3 & \sum x_i^4 & \ldots\ldots \sum x_i^{n+1} \\ \sum x_i^2 & \sum x_i^3 & \sum x_i^4 & \sum x_i^5 & \ldots\ldots \sum x_i^{n+2} \\ \sum x_i^3 & \sum x_i^4 & \sum x_i^5 & \sum x_i^6 & \ldots\ldots \sum x_i^{n+3} \\ \ldots & \ldots & \ldots & \ldots & \ldots \\ \sum x_i^n & \sum x_i^{n+1} & \sum x_i^{n+2} & \sum x_i^{n+3} & \ldots\ldots \sum x_i^{n+n} \end{bmatrix} \begin{bmatrix} a_0 \\ a_1 \\ a_2 \\ a_3 \\ \ldots\ldots \\ a_n \end{bmatrix} = \begin{bmatrix} \sum y_i \\ \sum y_i x_i \\ \sum y_i x_i^2 \\ \sum y_i x_i^3 \\ \ldots \\ \sum y_i x_i^n \end{bmatrix}$$

Solving the matrix equation yields values for constants $a_0, a_1, a_2, a_3, \ldots\ldots a_n$ as the case may be depending on the power of the polynomial.

From the above matrix; for our particular case; i.e. polynomial of the third order:

$$y = a_0 + a_1 x + a_2 x^2 + a_3 x^3 \qquad (11)$$

The equivalent matrix equation will be; ($n = 3$).

$$\begin{bmatrix} n & \sum x_i & \sum x_i^2 & \sum x_i^3 \\ \sum x_i & \sum x_i^2 & \sum x_i^3 & \sum x_i^4 \\ \sum x_i^2 & \sum x_i^3 & \sum x_i^4 & \sum x_i^5 \\ \sum x_i^3 & \sum x_i^4 & \sum x_i^5 & \sum x_i^6 \end{bmatrix} \begin{bmatrix} a_0 \\ a_1 \\ a_2 \\ a_3 \end{bmatrix} = \begin{bmatrix} \sum y_i \\ \sum y_i x_i \\ \sum y_i x_i^2 \\ \sum y_i x_i^3 \end{bmatrix}$$

3. Results and Discussion

Predictive values that determine the behaviour of micronutrient growth rate for six locations are presented in tables and figures below

Table: 1 comparison of calculated and measured values at various depths

Distance	Calculated Micronutrients Phosphorus	Measured Micronutrient Phosphorus
3	1.00E-06	1.10E-06

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6	1.21E-06	1.22E-06
9	1.80E-06	1.84E-06
12	3.99E-06	3.88E-06
15	8.92E-06	8.89E-06
18	1.77E-05	1.68E-05
21	3.15E-05	3.10E-05
24	5.14E-05	5.17E-05
27	7.80E-05	7.75E-05
30	1.14E-04	1.40E-04

Table: 2 comparisons of calculated and measured values at various depths

Distance	Calculated Micronutrients Phosphorus	Measured Micronutrient Phosphorus
3	1.00E-06	1.50E-06
6	1.21E-06	1,34E-06
9	1.80E-06	1.90E-06
12	3.99E-06	4.20E-06
15	8.92E-06	8.85E-06
18	1.77E-05	1.82E-05
21	3.15E-05	3.34E-05
24	5.14E-05	5.25E-05
27	7.80E-05	8.10E-05
30	1.14E-04	1.50E-04

Table: 3 comparisons of calculated and measured values at various depths

Distance	Calculated Micronutrients Phosphorus	Measured Micronutrients Phosphorus
3	1.00E-06	1.24E-06
6	1.21E-06	1.45E-06
9	1.80E-06	1.88E-05
12	3.99E-06	3.79E-05

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15	8.92E-06	8.78E-06
18	1.77E-05	1.88E-05
21	3.15E-05	3.22E-06
24	5.14E-05	5.25E-05
27	7.80E-05	7.88E-05
30	1.14E-04	1.20E-04

Table: 4 comparisons of calculated and measured values at various depths

Distance	Calculated Micronutrients Phosphorus	Measured Micronutrients Phosphorus
3	1.00E-06	1.00E-05
6	1.21E-06	1.43E-06
9	1.80E-06	1.76E-06
12	3.99E-06	3.55E-06
15	8.92E-06	8.56E-06
18	1.77E-05	1.88E-06
21	3.15E-05	3.45E-06
24	5.14E-05	5.35E-05
27	7.80E-05	7.99E-05
30	1.14E-04	1.56E-04

Table: 5 comparisons of calculated and measured values at various depths

Distance	Calculated Micronutrients Phosphorus	Measured Micronutrients Phosphorus
3	1.00E-06	1.54E-05
6	1.21E-06	1.57E-06
9	1.80E-06	1.98E-06
12	3.99E-06	4.11E-05
15	8.92E-06	8.99E-06

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18	1.77E-05	1.77E-05
21	3.15E-05	3.88E-05
24	5.14E-05	5.44E-06
27	7.80E-05	7.90E-05
30	1.14E-04	1.42E-04

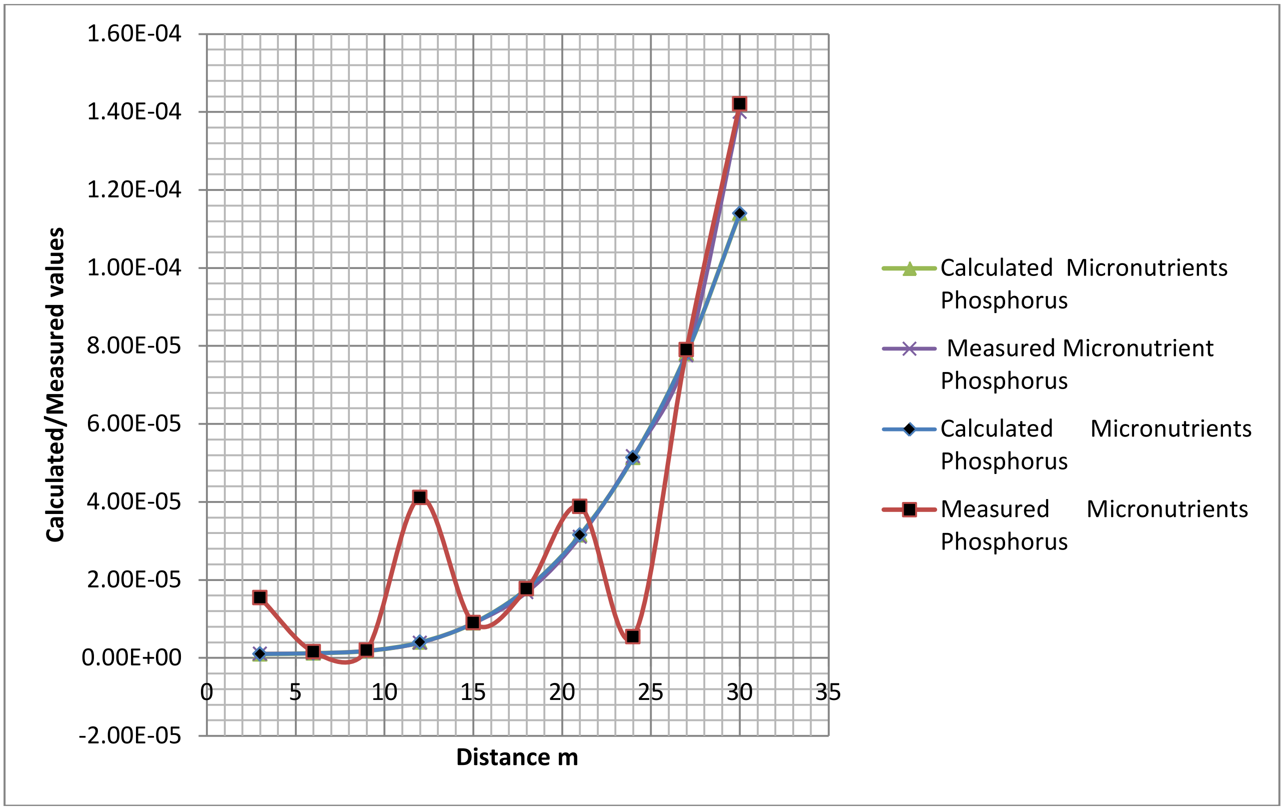

Figure: 1 comparison of calculated and measured values at various depths

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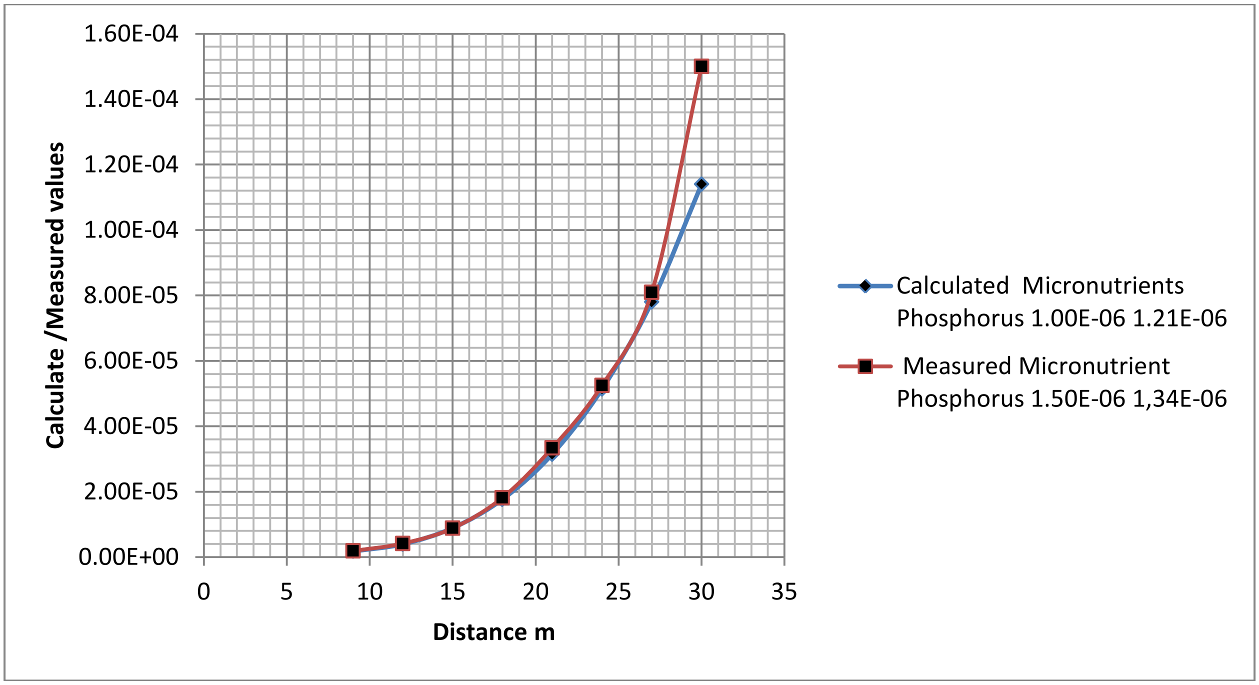

Figure: 2 comparisons of calculated and measured values at various depths

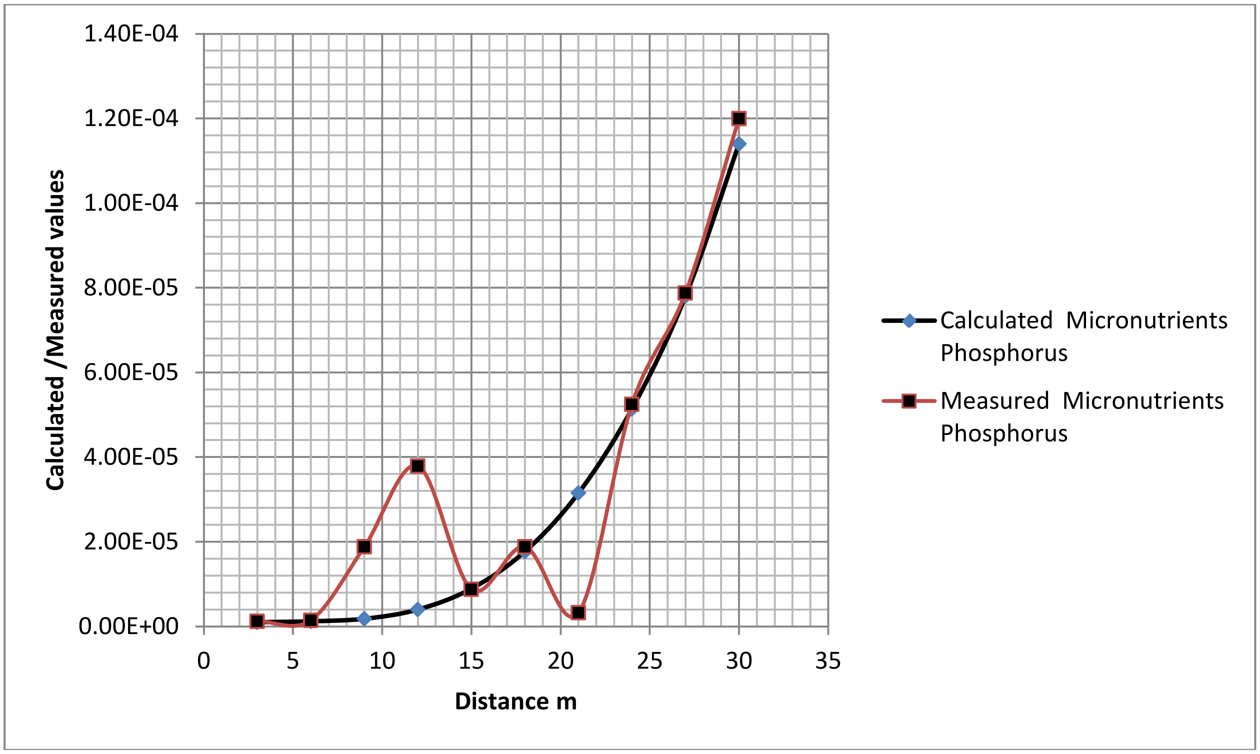

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Figure: 3 comparison of calculated and measured values at various depths

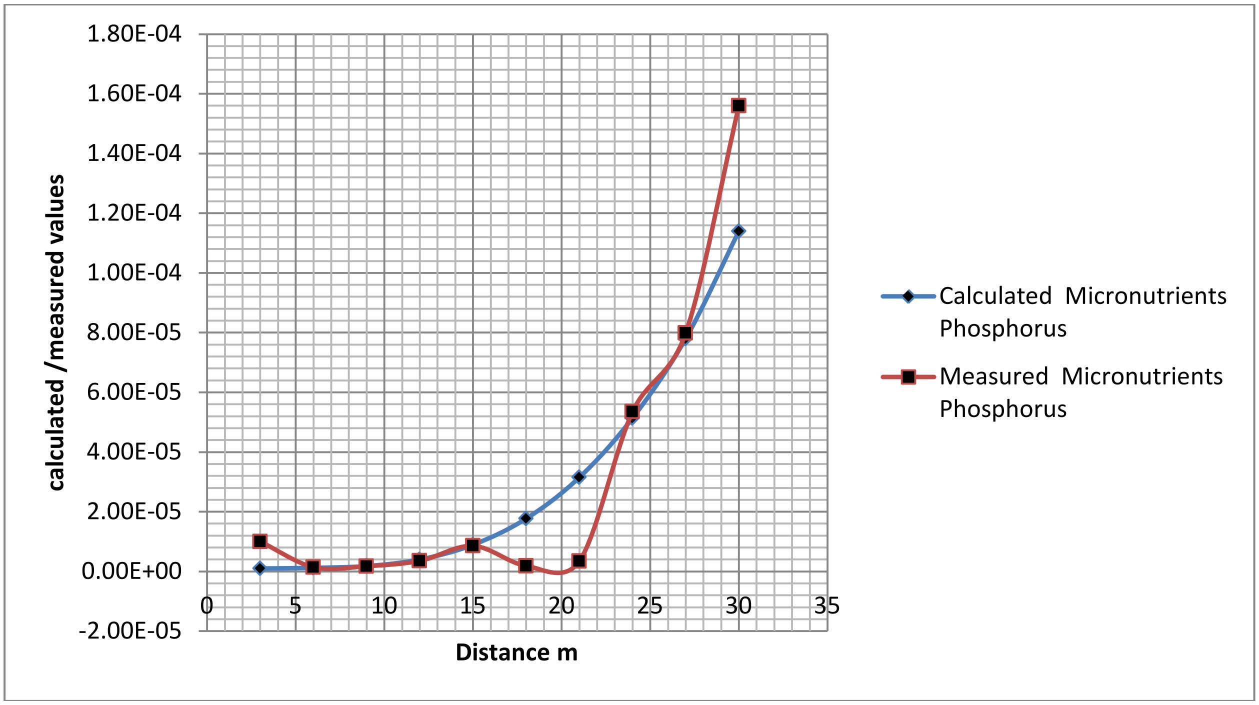

Figure: 4 comparisons of calculated and measured values at various depths

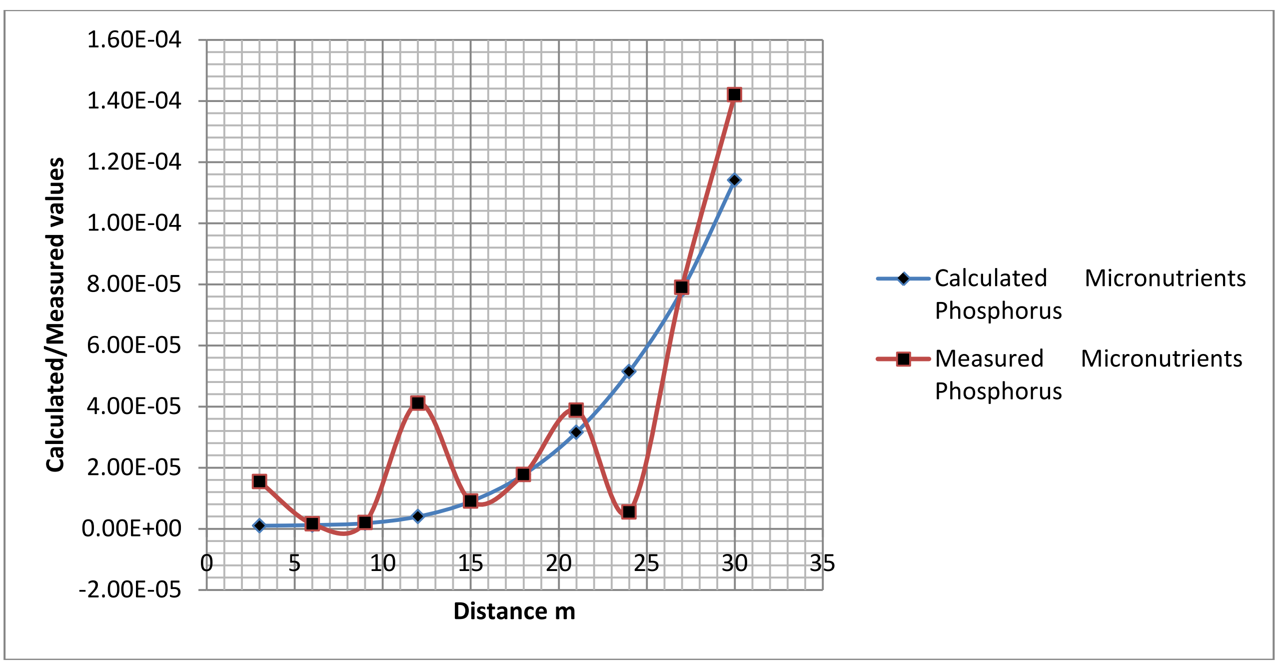

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Figure: 5 comparisons of calculated and measured values at various depths

Figure one shows that the predictive trend where found to increase gradually to the optimum value recorded at thirty meters, while the measured value fluctuate and recorded it lowest degree of concentration at twenty-four meters suddenly an increase were observed were the optimum value were recorded.

While figures two were slightly deferent from figure one, the micro nutrient of phosphorous experience a gradual increase at different formation to the point where the optimum value where recorded at thirty meters. Similar conditions were also experience for the measured value the optimum value where observed at thirty meters. Figure three observed a gradual increase from the predictive values at different formations, while the measured values experience fluctuation between three and twenty-one meters. Rapid increase where experience to where the optimum value were rescored at thirty meters. Figure four experience similar condition with the predictive values of figure three, whereby a gradual increase was observed to the optimum value that were recorded at thirty meters, while that of the measured values develop slight increase at three meters, and experience the lowest concentration at twenty-one meters, thus a rapid increase were observed at thirty meters. Figure five observed a gradual increase of the micro nutrient to the optimum value at thirty meters, while the measured values experience fluctuation between three and twenty-four meters, suddenly, a rapid increase was observed from twenty-seven to thirty meters where the optimum values were recorded at thirty meters. The predictive model from the figure presented compared favorably well with the measured values, fluctuations where also experienced in some of the locations as presented from the figures, these can be attributed to the rate of the position of phosphorous as a substrate utilization for microbial growth. The soil structural deposition where found to have influence on the variation of the formations, fluctuation where experienced from the measured values. Phosphorus is one of

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the micro nutrients that increase the microbial population of the soil. Porosity and permeability are some the factors that influence the vacillation of the micro nutrient, this type of microbial transport will have a high degree of concentration based on the substrate utilization, the study is imperative because the predictive model can be apply to determine the growth rate of micro nutrient in the study area.

4. Conclussion

Predictive model to monitor the growth rate of micro nutrient has been evaluated. the models were derived through a generated equations from experimental values, the derived models equations produced theoretical values that were compared with measure values from other locations, both parameters compared favorably well with the experimental value. The growth rate of micro nutrient were confirmed to increase concentration at shallow depths those location that inhibitors are not deposited, will definitely experienced high concentration of E.coli in shallow aquifers, thus, structural strata are influenced by high degree of porosity resulting to microbial transport and micro nutrient deposition in soil formation. Such formation characteristics are the fundamental influence that causes rapid growth rate of micro nutrient in a waste dump site resulting to ground water pollution in the study location.

References

Heathwaite. L., P. Haygarth, R. Matthews, N. Preedy, and P. Butler. 2005. Evaluating colloidal phosphorus delivery to surface waters from diffuse agricultural sources. *Journal of Environmental Quality* 34 (1): 287-298.

Hively, W.D., P. Gerard-Marchant, and T.S. Steenhuis. 2006. Distributed hydrological modeling of total dissolved phosphorus transport in an agricultural landscape II. Dissolved phosphorus transport. *Hydrology and Earth System Sciences* 10(2): 263-

Ilg, K., and M. Kaupenjohann. 2005. Colloidal and dissolved phosphorus in sandy soils as affected by phosphorus saturation. *Journal of Environmental Quality* 34: 926- 935.

Kleinman, P.J.A., B.A. Needelman, A.N. Sharpley, and R.W. McDowell. 2004. Using soil phosphorus profile data to assess phosphorus leaching potential in manured soils. *Soil Science Society of America Journal* 67 (1): 215-224.

Nelson, N.O., J.E. Parsons, and R.L. Mikkelson. 2005. Field-scale evaluation of phosphorus leaching in acid sandy soils receiving swine waste. *Journal of Environmental Quality* 34(6): 2024-2035.

Heathwaite. L., P. Haygarth, R. Matthews, N. Preedy, and P. Butler. 2005. Evaluating colloidal phosphorus delivery to surface waters from diffuse agricultural sources. *Journal of Environmental Quality* 34 (1): 287-298.

Hively, W.D., P. Gerard-Marchant, and T.S. Steenhuis. 2006. Distributed hydrological modeling of total dissolved phosphorus transport in an agricultural landscape II. Dissolved phosphorus transport. *Hydrology and Earth System Sciences* 10(2): 263-276.

Hunt, B. 1978. Dispersive sources in uniform ground-water flow. *American Society of Civil Engineering Journal Hydraulics Division* 104(HY1): 75-85.

Wagner K, Woodruff S. 1997. *Phase I Clean Lakes Project, Diagnostic and Feasibility Study of Lake Eucha.* Oklahoma Conservation Commission, Oklahoma City, OK.

Storm D.E., White M.J., Smolen M.D., Zhang H. 2001. *Modeling Phosphorus Loading for the Lake Eucha Basin.* Submitted to the Tulsa Metropolitan Utility Authority, Department of Biosystems and Agricultural Engineering, Oklahoma State University, Stillwater, Oklahoma, May 22, 2001.

Storm, D.E., M.J. White, and M.D. Smolen. 2002. *Modeling the Lake Eucha Basin Using SWAT 2000.* Submitted to the Tulsa Metropolitan Utility Authority, Department of Biosystems and Agricultural Engineering, Oklahoma State University, Stillwater, Oklahoma, August 9, 2002.

John W. F 2006 subsurface transport of phosphorus in riparian loodplains: tracer and phosphorus transport experiments MSC Thesis University of Mississippi Oxford, MS