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Research article

Phosphorus Transport Influenced by Exponential Homogeneous Dispersion Coefficient and Velocity of Flow in Eleme Stream

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Abstract

Phosphorus as one of the microelement was observed to predominantly deposit in the study environment, this were experienced from physiochemical investigation carried out in the stream, the examination observed the predominant deposition of increased phosphorus in different station point of discharge, this implies that there are some significant factors causing such increase of the contaminant in the stream, the evaluation generated other parameters that could influenced the exponential state of the contaminant, such condition call for serious concern, thus thorough examination of these parameters that affect the growth rate of phosphorus in the stream, the transport of this microelement experienced increase in all the figures based on the points source of discharge monitored, derived model were applied to monitor the behaviour of phosphorus in the stream, this were carried out through model and simulation, the system monitored other influential parameters that pressured the growth rate of the contaminant at different point source, gradual growth rate to the optimum level were experienced based on the continuity process of phosphorus substance discharged in the stream, the study also observed other effect from phosphorus deposition at high rate in the stream, the substance were observed in the stream to increase rapid rate of microbes in the stream, an increase of Eutrophication in the stream expressed high rate of phosphorus in the environment, there various rates of concentration ranged from 0.000352718-0.437434594,0.00029158-0.361612598,0.00028183-0.331253401, 0.000263182- 0.316679675, 0.000235172-0.293114139, 0.000270628- 0.347346913, the derived simulation values were compared with experimental data, and both parameters developed best fits correlation, the study is imperative because it has monitored various rate of velocity that influenced dispersion of phosphorus substance in the stream, it has also expressed the rate of homogeneous velocity of flows as it has been through evaluated.

Keywords: Phosphorus; Transport dispersion coefficient velocity and flow

Introduction

Preceding segments explain the pathogen pollution in various ambient water bodies and possible sources. Factors influencing pathogen continued existence and transport in ambient water bodies are of a huge interest Pathogen concentration in water bodies are influenced by many environmental factors. Scott et al. [1] several studies have been reviewed studies explaining the environmental factors impacts on pathogen survival are accessible Brookes et al. [2]; Fayer and Trout [3]; Gerba 4]; Hipsey et al. [5] Eluozo and Ezeilo [6]. The consequence of these factors has variation with season and these types of ambient water bodies Van Donsel et al. [7]; Gallagher and Spino [8]; Niemi [9] Eluozo and Ezeilo [10], Pandey [12]. Modeling In- Stream *Escherichia coli* Concentrations Graduate Dissertation Iowa state university pp 62-75. Other studies carried out such as for stream water, temperature is considered to be the governing factor in *E. coli* continued existence McFeters and Stuart [12] Eluozo and Ezeilo [13]; meanwhile, in the study of groundwater and reservoir, the existence of predators controls their survival Wcislo and Chrost [14]; Gordon and Toze [15]; John and Rose [16] Eluozo and Ezeilo [17], Eluozo and Amadi [18], Eluozo and Amadi [19]. In another development, solar radiation is considered to be the most significant factor that affect the survival of pathogens; more so, the effect may definitely vary with depth of water, including the of type water bodies, and type of pathogen Sinton et al. [20]. Sunlight For example, is an inactivation rates that definitely vary. These are from greatest to least, because they are: coliforms > enterococci > F-RNA phages > somatic coliphages Davies-Colley et al. [21]; Davies-Colley et al. [22]; Davies-Colley et al. [23] Eluozo and Afiibor [24] Eluozo and Afiibor [25]. Other research study carried out expressed the sunlight inactivation rate as: *enterococci* > *fecal coliforms* > *E. coli* > *somatic coliphages* > F-RNA phages Sinton et al. [20], Eluozo [26].

Theoretical Background

$$\frac{dc}{dx} + \beta(x)K = A(x) \quad (1)$$

Nomenclatures

C = Concentration

B = Fluid Density

K = Dispersions

A= Velocity of flow

D = Distance

Multiplying the equation through by $C[x]$, we have:

$$C(x)\frac{dC}{dx} + C(x)\beta(x)K = C(x)A(x) \quad (2)$$

Let $P(x) = C(x)\beta(x)$ (3)

Then Equation (2), we have:

$$C(x)\frac{dC}{dx} + C(x)\beta(x)K = C(x)A(x) \quad (4)$$

$$C(x)\frac{dC}{dx} + P(x)K = C(x)A(x) \quad (5)$$

$$C(x)P^1 + P(x)K = C(x)A(x) \quad (6)$$

$$C(x)P^1 = C(x)A - P(x)K \quad (7)$$

Differentiate 2nd term on the left-hand side of (6) with respect to x, we have

$$K\frac{dC}{dx} = C(x)A(x) - C(x)P^1 \quad (8)$$

$$\frac{dC}{dx} = \frac{1}{K}\left[C(x)A(x) - C(x)P^1\right] \quad (9)$$

$$\frac{dC}{dx} = \frac{C(x)}{K}\left[A(x) - P^1\right] \quad (10)$$

Applying separation of variables, by dividing through by C(x) and cross multiply by dx, gives:

$$\frac{dC}{C} = \frac{1}{K}\left[A(x) - P^1\right]dx \quad (11)$$

$$\frac{1}{C(x)}dC = \frac{1}{K}\left[A(x) - P^1\right]dx \quad (12)$$

$$\frac{1}{C(x)}dC = \left(\frac{A(x)}{K} - \frac{P^1}{K}\right)dx \quad (13)$$

$$\int \frac{1}{C(x)}dC = \int\left(\frac{A(x)}{K} - \frac{P^1}{K}\right)dx + \eta \quad (14)$$

$$\ln C(x) = \int A(x)dx - \int \frac{P^1}{K}dx + \eta \quad (15)$$

$$\ln C(x) = \frac{1}{K}\left[Ax - P^1\right]x + \eta \quad (16)$$

$$\text{h } C(x) = \left(\frac{A(x)}{K} - \frac{P^1}{K}\right)x + \eta \quad (17)$$

Taking exponent of both side of the equation

$$C(x) = \ell^{\left(\frac{A(x)}{K} - \frac{P^1}{K} + \eta\right)} \quad (18)$$

$$C(x) = D\ell^{\frac{1}{K}\left(Ax - P^1x\right)} \quad (19)$$

Materials and Method

Standard laboratory experiment where performed to monitor Phosphorus a using the standard method for the experiment at different sample at different station, the water sample were collected in sequences base on specification stipulated at different locations, this samples collected at different location generated variations at different distance producing different Phosphorus concentration through physiochemical analysis, the experimental result were compared with the theoretical values for model validation [27,28].

Results and Discussion

Table 1-6 and Figure 1-6 explained the behavior of the microelement growth rate in the stream, the figures shows exponential growth rate, this implies that the point source of the microelement discharging into the river are in continues process, the discharge from human settlers in the environment continue to increase, the concentration in the stream cause higher rate of increase from the point source of discharge, the trend gradual increase from the point source to optimum rate, such condition were monitor in the environment in other to determine the rate of it deposition at distance of ninety meters, because of the gradual increase in the stream, this condition implies that the system are influenced by other significant parameters that should be part of the transport system, the growth rate of both phosphorus are basically on the conditions observed in the study environment, the stream experienced heterogeneous velocity at different locations, the shape of the stream and other environmental factor were observed to influence the velocity of flow, but the trend monitored the dispersion coefficient effect on the stream, the growth rate of the microelement explained the rate of velocity of flows and the variation of dispersion coefficients in the transport process, based on this factors exponential phase of phosphorus were predominantly observed in the study area, the predictive and experimental values developed the gradual increase with higher percentage of best fits correlation.

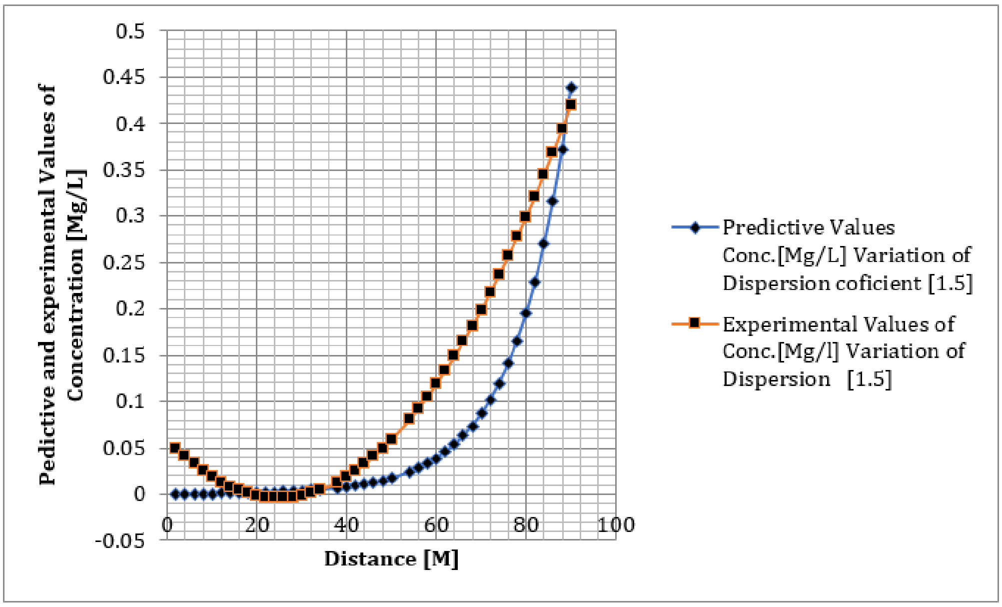

Figure 1: Predictive and Experimental Values of Phosphorus Concentration at Different Distance.

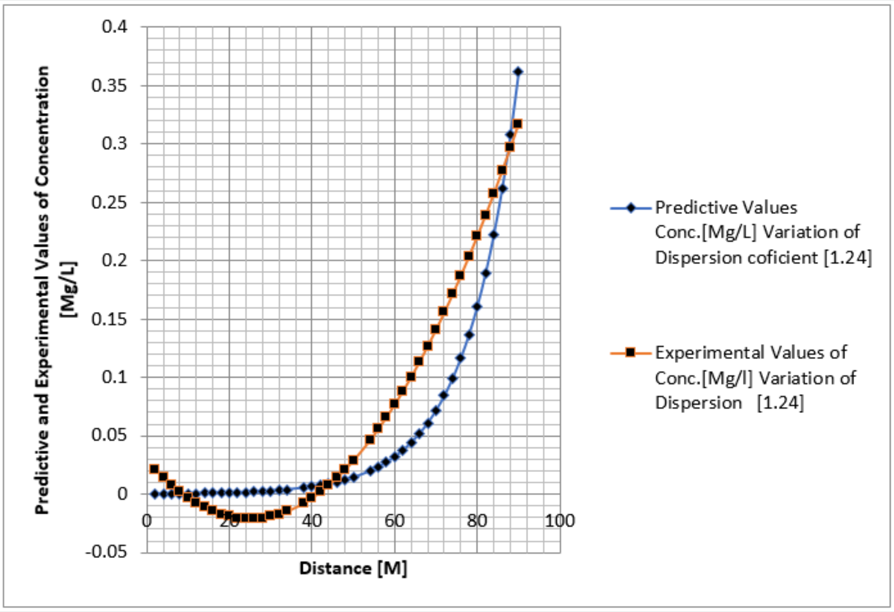

Figure 2: Predictive and Experimental Values of Phosphorus Concentration at Different Distance.

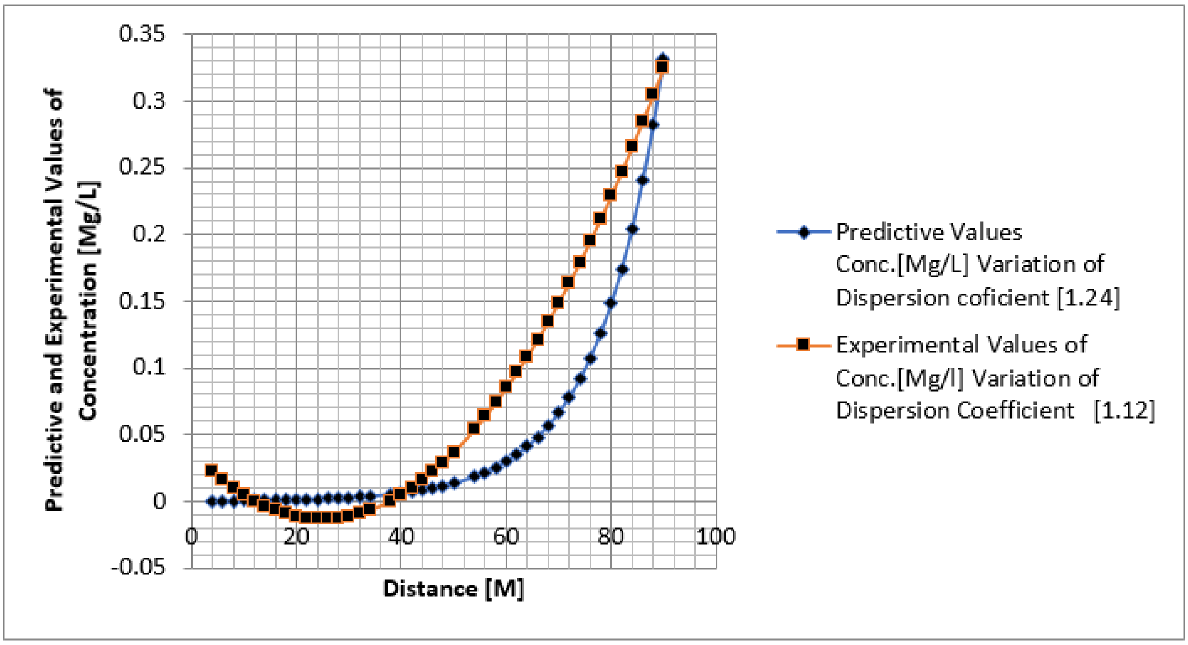

Figure 3: Predictive and Experimental Values of Phosphorus Concentration at Different Distance.

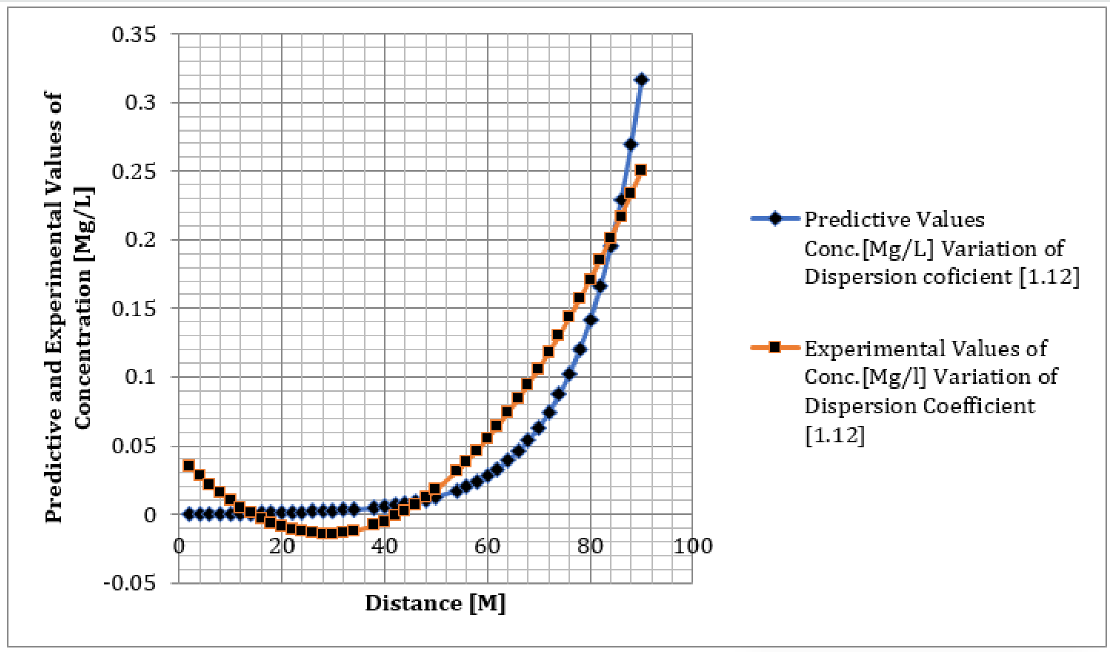

Figure 4: Predictive and Experimental Values of Phosphorus Concentration at Different Distance.

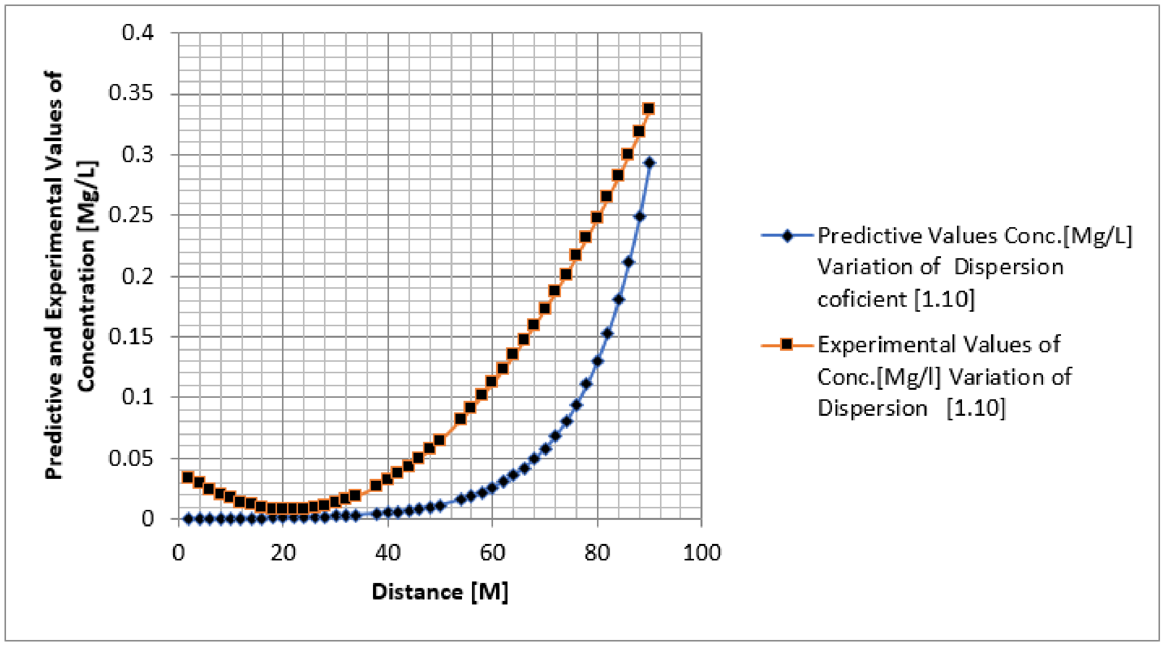

Figure 5: Predictive and Experimental Values of Phosphorus Concentration at Different Distance.

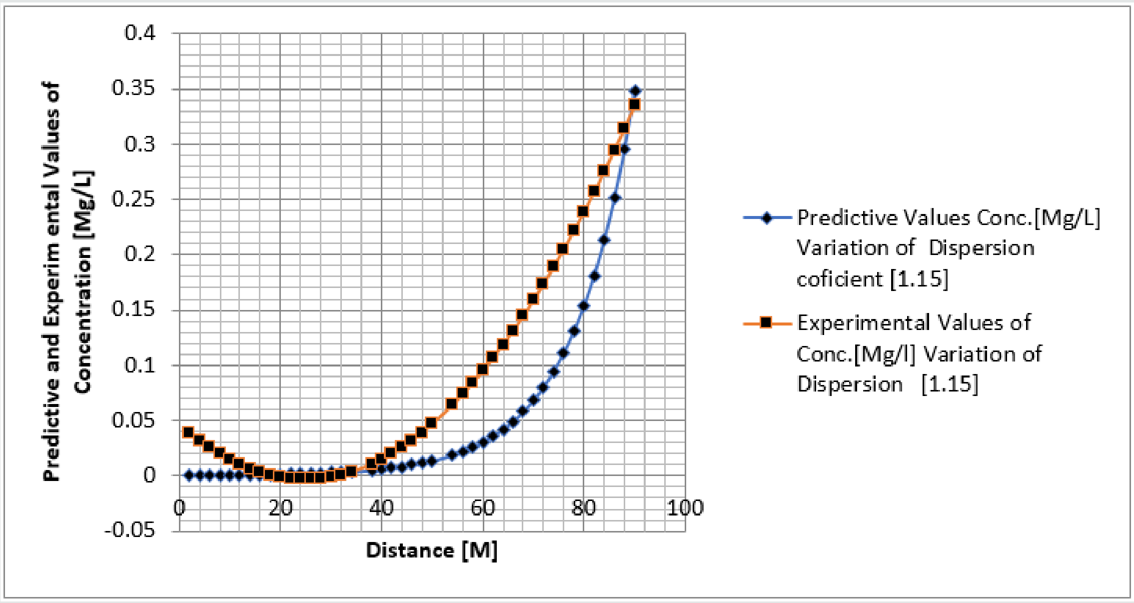

Figure 6: Predictive and Experimental Values of Phosphorus Concentration at Different Distance.

Table 1: Predictive and Experimental Values of Phosphorus Concentration at Different Distance.

Distance [x]	Predictive Values Conc [Mg/L] Variation of Dispersion Coefficient [1.5]	Experimental Values of Conc [Mg/l] Variation of Dispersion [1.5]
2	0.000352718	0.0494
4	0.0004147	0.0406
6	0.000487574	0.0326
8	0.000573254	0.0254
10	0.00067399	0.019
12	0.000792429	0.0134
14	0.00093168	0.0086
16	0.001095401	0.0046
18	0.001287893	0.0014
20	0.00151421	-0.001
22	0.001780298	-0.0026
24	0.002093144	-0.0034
26	0.002460966	-0.0034
28	0.002893424	-0.0026
30	0.003401877	-0.001
32	0.003999678	0.0014
34	0.004702529	0.0046
38	0.006500466	0.0134
40	0.007642773	0.019
42	0.008985815	0.0254
44	0.010564865	0.0326
46	0.012421397	0.0406
48	0.014604171	0.0494
50	0.017170518	0.059
54	0.02373539	0.0806
56	0.027906339	0.0926
58	0.032810236	0.1054
60	0.038575879	0.119
62	0.045354702	0.1334
64	0.053324747	0.1486
66	0.062695345	0.1646
68	0.073712608	0.1814
70	0.086665903	0.199
72	0.101895441	0.2174
74	0.119801219	0.2366
76	0.140853526	0.2566
78	0.165605292	0.2774
80	0.19470661	0.299
82	0.228921816	0.3214
84	0.269149556	0.3446
86	0.316446396	0.3686
88	0.372054567	0.3934
90	0.437434594	0.419

Table 2: Predictive and Experimental Values of Phosphorus Concentration at Different Distance.

Distance [x]	Predictive Values Conc [Mg/L] Variation of Dispersion Coefficient [1.24]	Experimental Values of Conc [Mg/l] Variation of Dispersion Coefficient [1.24]
2	0.000292	0.02132
4	0.000343	0.01428
6	0.000403	0.00788
8	0.000474	0.00212
10	0.000557	-0.003
12	0.000655	-0.00748
14	0.00077	-0.01132
16	0.000906	-0.01452
18	0.001065	-0.01708
20	0.001252	-0.019
22	0.001472	-0.02028
24	0.00173	-0.02092
26	0.002034	-0.02092
28	0.002392	-0.02028
30	0.002812	-0.019
32	0.003306	-0.01708
34	0.003887	-0.01452
38	0.005374	-0.00748
40	0.006318	-0.003
42	0.007428	0.00212
44	0.008734	0.00788
46	0.010268	0.01428
48	0.012073	0.02132
50	0.014194	0.029
54	0.019621	0.04628
56	0.023069	0.05588
58	0.027123	0.06612
60	0.031889	0.077
62	0.037493	0.08852
64	0.044082	0.10068
66	0.051828	0.11348
68	0.060936	0.12692
70	0.071644	0.141
72	0.084234	0.15572
74	0.099036	0.17108
76	0.116439	0.18708
78	0.1369	0.20372
80	0.160957	0.221
82	0.189242	0.23892
84	0.222497	0.25748
86	0.261596	0.27668
88	0.307565	0.29652
90	0.361613	0.317

Table 3: Predictive and Experimental Values of Phosphorus Concentration at Different Distance.

Distance [x]	Predictive Values Conc [Mg/L] Variation of Dispersion coefficient [1.24]	Experimental Values of Conc [Mg/l] Variation of Dispersion Coefficient [1.12]
2	0.000282	0.02932
4	0.000331	0.02228
6	0.000389	0.01588
8	0.000456	0.01012
10	0.000536	0.005
12	0.000629	0.00052
14	0.000739	-0.00332
16	0.000868	-0.00652
18	0.001019	-0.00908
20	0.001197	-0.011
22	0.001405	-0.01228
24	0.00165	-0.01292
26	0.001938	-0.01292
28	0.002276	-0.01228
30	0.002672	-0.011
32	0.003138	-0.00908
34	0.003685	-0.00652
38	0.005081	0.00052
40	0.005967	0.005
42	0.007007	0.01012
44	0.008228	0.01588
46	0.009662	0.02228
48	0.011346	0.02932
50	0.013324	0.037
54	0.018373	0.05428
56	0.021575	0.06388
58	0.025336	0.07412
60	0.029752	0.085
62	0.034937	0.09652
64	0.041026	0.10868
66	0.048177	0.12148
68	0.056574	0.13492
70	0.066435	0.149
72	0.078014	0.16372
74	0.091611	0.17908
76	0.107578	0.19508
78	0.126328	0.21172
80	0.148346	0.229
82	0.174202	0.24692
84	0.204565	0.26548
86	0.240219	0.28468
88	0.282087	0.30452
90	0.331253	0.325

Table 4: Predictive and Experimental Values of Phosphorus Concentration at Different Distance.

Distance [x]	Predictive Values Conc [Mg/L] Variation of Dispersion coefficient [1.12]	Experimental Values of Conc [Mg/l] Variation of Dispersion Coefficient [1.12]
2	0.000263	0.03528
4	0.000309	0.02812
6	0.000363	0.02152
8	0.000427	0.01548
10	0.000502	0.01
12	0.000589	0.00508
14	0.000692	0.00072
16	0.000813	-0.00308
18	0.000956	-0.00632
20	0.001123	-0.009
22	0.001319	-0.01112
24	0.00155	-0.01268
26	0.001821	-0.01368
28	0.00214	-0.01412
30	0.002514	-0.014
32	0.002954	-0.01332
34	0.00347	-0.01208
38	0.004791	-0.00792
40	0.005629	-0.005
42	0.006613	-0.00152
44	0.00777	0.00252
46	0.009129	0.00712
48	0.010726	0.01228
50	0.012602	0.018
54	0.017397	0.03112
56	0.02044	0.03852
58	0.024015	0.04648
60	0.028216	0.055
62	0.033152	0.06408
64	0.03895	0.07372
66	0.045764	0.08392
68	0.053769	0.09468
70	0.063174	0.106
72	0.074224	0.11788
74	0.087208	0.13032
76	0.102462	0.14332
78	0.120384	0.15688
80	0.141442	0.171
82	0.166183	0.18568
84	0.195252	0.20092
86	0.229405	0.21672
88	0.269533	0.23308
90	0.31668	0.25

Table 5: Predictive and Experimental Values of Phosphorus Concentration at Different Distance.

Distance [x]	Predictive Values Conc [Mg/L] Variation of Dispersion Coefficient [1.10]	Experimental Values of Conc [Mg/l] Variation of Dispersion Coefficient [1.10]
2	0.000235	0.03428
4	0.000277	0.02912
6	0.000325	0.02452
8	0.000382	0.02048
10	0.00045	0.017
12	0.000529	0.01408
14	0.000622	0.01172
16	0.000731	0.00992
18	0.000859	0.00868
20	0.001011	0.008
22	0.001188	0.00788
24	0.001397	0.00832
26	0.001643	0.00932
28	0.001932	0.01088
30	0.002272	0.013
32	0.002671	0.01568
34	0.003141	0.01892
38	0.004343	0.02708
40	0.005107	0.032
42	0.006005	0.03748
44	0.007061	0.04352
46	0.008303	0.05012
48	0.009763	0.05728
50	0.011479	0.065
54	0.015872	0.08212
56	0.018663	0.09152
58	0.021946	0.10148
60	0.025805	0.112
62	0.030343	0.12308
64	0.035679	0.13472
66	0.041954	0.14692
68	0.049331	0.15968
70	0.058007	0.173
72	0.068208	0.18688
74	0.080203	0.20132
76	0.094308	0.21632
78	0.110893	0.23188
80	0.130394	0.248
82	0.153325	0.26468
84	0.180289	0.28192
86	0.211995	0.29972
88	0.249276	0.31808
90	0.293114	0.337

Table 6: Predictive and Experimental Values of Phosphorus Concentration at Different Distance.

Distance [x]	Predictive Values Conc [Mg/L] Variation of Dispersion Coefficient [1.15]	Experimental Values of Conc [Mg/l] Variation of Dispersion Coefficient [1.15]
2	0.000271	0.03932
4	0.000318	0.03228
6	0.000375	0.02588
8	0.000441	0.02012
10	0.000519	0.015
12	0.00061	0.01052
14	0.000718	0.00668
16	0.000845	0.00348
18	0.000994	0.00092
20	0.00117	-0.001
22	0.001377	-0.00228
24	0.00162	-0.00292
26	0.001906	-0.00292
28	0.002243	-0.00228
30	0.002639	-0.001
32	0.003105	0.00092
34	0.003653	0.00348
38	0.005058	0.01052
40	0.005952	0.015
42	0.007003	0.02012
44	0.00824	0.02588
46	0.009695	0.03228
48	0.011408	0.03932
50	0.013423	0.047
54	0.018584	0.06428
56	0.021867	0.07388
58	0.02573	0.08412
60	0.030275	0.095
62	0.035623	0.10652
64	0.041916	0.11868
66	0.04932	0.13148
68	0.058032	0.14492
70	0.068283	0.159
72	0.080345	0.17372
74	0.094537	0.18908
76	0.111236	0.20508
78	0.130886	0.22172
80	0.154006	0.239
82	0.18121	0.25692
84	0.21322	0.27548
86	0.250884	0.29468
88	0.295201	0.31452
90	0.347347	0.335

Conclusion

Phosphorus deposition in Eleme stream were monitor at different locations, this were to evaluate the rate of its concentration at different station point of discharge in the stream, the study evaluate this microelement based on it exponential growth rate in the stream, this cause for thorough study in other to determine their various rate of increase at the stream, the rate of concentration in some location generated Eutrophication in the stream, the variations from velocity of flow were observed to influenced the rate dispersion of phosphorus in the study environment, this on physical process shows the rate water hyacinth on the stream, this condition implies that constant discharge of the microelement will definitely generate high increase of microbes in the river thus developed microbial increase from these points of discharge, the study has definitely express various rates of discharge and it level of concentration at different point, such study expressed thorough evaluation of the factor that cause the increase of phosphorus transport in the stream, the study has expressed the fundamentals causes of exponential growth rate of contaminant in the stream, the application of one dimensional flow transport system has express the variation effect of dispersion at various point source discharge locations in the study area. The predictive and experimental values developed best fits correlations.

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