World Journal of Science and Technology Research
Vol. 1, No. 3, May 2013, PP: 53 - 66,
Available online www.wjst.org

Research article

MATHEMATICAL MODEL TO MONITOR THE BEHAVIOUR OF NITROGEN ON SALMONELLA TRANSPORT IN HOMOGENOUES FINE SAND IN COASTAL AREA OF PORT HARCOURT, NIGER DELTA OF NIGERIA

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Abstract

The deposition of nitrogen in coastal area cannot be compare to upland locations, these two location establish different degrees of formation characteristics, it also reflect on the transport of salmonella, the study area is coastal location, it has different geological formation compared to other areas , the deposition of nitrogen were found to be a common influence on salmonella deposition in the coastal of port Harcourt, several concept has been applied to monitor the deposition of nitrogen and increase of salmonella in the study location but could not perfectly solve the problem, base on this condition, mathematical model were found suitable after thorough examination to monitor the deposition level of nitrogen and determine the rate of concentration of salmonella in the study area, the model was develop through the governing equation formulated to monitor the deposition of nitrogen and salmonella in homogeneous fine sand , the concept were to determine the behaviour of salmonella in coastal area of Port Harcourt and predict the rate of increase in coastal aquifers. The study is imperative it will streamline the behaviour of the microbes under the influence of nitrogen deposition in coastal area of Port Harcourt.

Key words: mathematical model, behaviour of nitrogen, salmonella and fine sand

1. Introduction

With over a billion individual cells and estimates of 104–105 distinct genomes per gram of soil (Gans et al., 2005; Tringe et al., 2005; Fierer et al., 2007b Katherine, 2011), bacteria in soil are the reservoirs for much of Earth's genetic biodiversity. This vast phylogenetic and functional diversity can be attributed in part to the dynamic physical and chemical heterogeneity of soil, which results in spatial and temporal separation of microorganisms (Papke and Ward, 2004). Given the high diversity of carbon (C) – rich compounds in soils, the ability of each taxon to compete for only a subset of resources could also contribute to the high diversity of bacteria in soils through resource partitioning (Zhou et al., 2002 Katherine et al 2011). Indeed, Waldrop and Firestone (2004) have demonstrated distinct substrate preferences by broad microbial groups in grassland soils and C resource partitioning has been demonstrated to be a key contributor to patterns of bacterial co-existence in model communities on plant surfaces (Wilson and Lindow, 1994). The development of high-throughput tools to assess the composition of soil bacterial communities is rapidly contributing to an improved understanding of bacterial diversity and biogeographically distribution (Drenovsky et al., 2009; Lauber et al., 2009; Chu et al., 2010 Katherine et al 2011). However, our ability to assess the functions of different bacterial taxa has not kept pace (Green et al., 2008). This limits our ability to interpret the functional consequences of shifts in community composition in response to environmental changes (Stein and Nicol, 2011).there several concept applied to monitor the trace of the bacteria For this reason, the use of tracer molecules such as stable-isotopes and the thymidineanalog, 3-bromodeoxyuridine (BrdU), have been widely adopted in an effort to connect phylogeny to function. Stable-isotopes, particularly the heavy carbon isotope 13C, have been frequently used to identify microbial community members capable of catabolizing particular substrates (Radajewski et al., 2000; Griffiths et al., 2004; Buckley et al., 2007; Feth El Zahar et al., 2007; Schwartz, 2007). This technique requires separation of nucleic acids based on buoyant density, so high concentrations of isotopically labeled substrate are needed. Thus, this approach is costly and impractical for many complex organic compounds that are not commercially available. An alternative is the use of BrdU to monitor cell division following substrate addition. This approach was first applied to the study of bacterial populations over a decade ago (Urbach et al., 1999) and it has since been used to identify soil bacterial taxa that respond to various environmental stimuli (Borneman, 1999; Yin et al., 2000; Artursson and Jansson, 2003; Artursson et al., 2005). Recently, BrdU incorporation has been shown to detect a broad diversity of bacterial phyla in marine systems (Edlund et al., 2008) and fungal taxa in temperate (Hanson et al., 2008) and boreal forest soils (Allison et al., 2008).

2. Theoretical background

The behaviour of nitrogen in coastal area of Port Harcourt is through the stratification of the formation in the study area. Geological setting of the formation were found to deposit lots of variation in the formation of the soil. this influential condition manifest on the deposition of salmonella in the coastal formation, this condition were thoroughly detailed in the hydrological studies carried out in the study area, the study streamline the formation variables under the influences of hydrogeological condition in the formation, the process were able to investigate some pollutant that deposit in the formation, but could not find better solution to handle the challenges. To find better solution, mathematical model were find suitable to generate better solution, the study were carried out through developed mathematical equation, this expression were generated through the variables that will always influences the system on the deposition of nitrogen, the concept were also to see the rate of influence on salmonella in the coastal location, the model were derived in stages and numerous models were develop according to the behaviour of salmonella and nitrogen in the system, the model will applied to monitor the deposition and behaviour of both parameters in the study area.

3. Governing equation

$$V\frac{\partial Cs}{\partial t} = \frac{\partial Cs}{\partial z} q_z C_s + Ds\frac{\partial Cs}{\partial z} - M_b \frac{\mu_o}{\gamma_o}\frac{\partial Cs}{\partial z} + \frac{\partial Cs}{\partial t}\frac{Cs}{K_{So}+Cs} + \frac{\partial Cs}{\partial z}\frac{C_A}{K_{Ao}+C_A} \quad \ldots\ldots\ldots (1)$$

Equation [1] express the parameters that influence the behaviour of nitrogen on salmonella transport in homogeneous fine sand, this mathematical expression are for coastal area of port Harcourt, the study location are deltaic in nature, there lots of challenges in coastal area of port Harcourt, so the expressions were formulated with the parameters that influence the coastal area base on the geological setting in the study location, the governing equitation consider the variation of formation characteristics as express mathematically state in the equation to monitor the behaviour under the influence of salmonella migration in the study area.

$$V\frac{\partial Cs_1}{\partial t} = M_b \frac{\mu_o}{\gamma_o}\frac{\partial Cs_1}{\partial z} \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

$$\left.\begin{aligned} x &= 0 \\ Cs_{(o)} &= 0 \\ \frac{\partial Cs_1}{\partial t}\Big|\, t &= 0,\ B \end{aligned}\right\} \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

$$V\frac{\partial Cs_2}{\partial t} = D_s \frac{\partial Cs_2}{\partial z}\frac{C_A}{K_{Ao}+C_A} \quad \ldots\ldots\ldots\ldots\ldots\ldots (4)$$

$$\left.\begin{aligned} x &= 0 \\ t &= 0 \\ Cs_{(o)} &= 0 \\ \frac{\partial Cs_2}{\partial t}\Big|\, t &= 0,\ B \end{aligned}\right\} \quad \ldots\ldots\ldots\ldots\ldots\ldots (5)$$

$$V\frac{\partial Cs_3}{\partial t} = \frac{\partial Cs_3}{\partial t}\frac{Cs_o}{K_{so}+C_o} \quad \ldots\ldots\ldots\ldots\ldots\ldots (6)$$

$$\left.\begin{aligned} t &= 0 \\ Cs_{(o)} &= 0 \\ \frac{\partial Cs_3}{\partial t}\Big|\, t &= 0,\ B \end{aligned}\right\} \quad \ldots\ldots\ldots\ldots\ldots\ldots (7)$$

$$V\frac{\partial Cs_4}{\partial t} = D_s \frac{\partial Cs_4}{\partial z} \quad \ldots\ldots\ldots\ldots\ldots\ldots (8)$$

$$\left.\begin{aligned} t &= 0 \\ x &= 0 \\ Cs_{(o)} &= 0 \end{aligned}\right\} \quad \ldots\ldots\ldots\ldots\ldots\ldots (9)$$

$$\frac{\partial Cs_4}{\partial t}\Big|\, t = 0,\ B$$

appliance of split method techniques was find suitable, this by splitting the equations in accordance with various conditions that are considered to influence the microbial behaviour in the system, the system express various influence on the transport process, this is to ensure that the microbes develop several behaviour at different stratification of the formation in phreatic aquifers, this condition were found necessary since the substrate has an interaction with the contaminant growth in the formations, subject to this relation, the rate of concentration are found to reflect on the growth rate of microbes in soil and water environments, so it is imperative to ensure that the substrate is thoroughly examined thus monitor the rate of deposition at various formation, and predict their depositions at different depths in the study area

$$V\frac{\partial Cs_5}{\partial t} + \frac{\partial Cs_5}{\partial z} q_z Cs \qquad \ldots\ldots\ldots\ldots\ldots \quad (10)$$

$$\left.\begin{array}{l} t = 0 \\ x = 0 \\ Cs_{(o)} = 0 \\ \frac{\partial Cs_5}{\partial t}\Big|\, t = 0,\ B \end{array}\right\} \qquad \ldots\ldots\ldots\ldots\ldots \quad (11)$$

$$M_b \frac{\mu_o}{\gamma_o}\frac{\partial Cs_6}{\partial z} = \frac{\partial Cs_6}{\partial t}\frac{C_A}{K_{Ao} + C_A} - = 0 \qquad \ldots\ldots\ldots\ldots\ldots \quad (12)$$

$$\left.\begin{array}{l} x = 0 \\ Cs_{(o)} = 0 \\ \frac{\partial Cs}{\partial t}\Big|\, t = 0,\ B \end{array}\right\} \qquad \ldots\ldots\ldots\ldots\ldots \quad (13)$$

Applying direct integration on (2)

$$\frac{\partial Cs_1}{\partial t} = M_b \frac{\mu_o}{\gamma_o} + K_1 \qquad \ldots\ldots \ (14)$$

Again, integrate equation (14) directly yield

$$VCs = M_b \frac{\mu_o}{\gamma_o} + K_1 + K_2 \qquad \ldots\ldots\ldots\ldots\ldots \quad (15)$$

Subject to equation (3) we have

$$Cs_{(o)} = K_2 \qquad \ldots\ldots\ldots\ldots\ldots \quad (16)$$

Subjecting equation (15) to (3)

$$\text{At } \left.\frac{\partial Cs_1}{\partial t}\right|_{t=0} = 0 \quad Cs_{(o)} = Cs_o$$

Yield

$$O = VCs_o = K_2$$

$$K_2 = VC_o \qquad \ldots\ldots\ldots\ldots\ldots \quad (17)$$

So that we put (16) and (17) into (15), we have

$$Cs_1 = VCs_1 t - M_b \frac{\mu_o}{\gamma_o} Cst + Cs_o \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (18)$$

$$Cs_1 = V = Cs_o - M_b \frac{\mu_o}{\gamma_o} Cst \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (19)$$

$$\Rightarrow Cs_1 \left[Cs_1 - Vt \right] = Cs_o \left[Cs_1 - M_b \frac{\mu_o}{\gamma_o} \right] \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (20)$$

$$\Rightarrow Cst = Cs_o \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (21)$$

$$V \frac{\partial Cs_2}{\partial t} = \frac{\partial Cs_2}{\partial z} \frac{C_A}{K_{Ao} + C_A} \qquad \ldots\ldots\ldots \ (4)$$

We approach this system using the Bernoulli's method of separation of variables.

$$\text{i.e. } Cs_2 = ZT \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (22)$$

$$\frac{\partial Cs_2}{\partial t} = ZT^1 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (23)$$

$$\frac{\partial Cs_2}{\partial z} = Z^1 T \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (24)$$

Put (23) and (24) into (25), so that we have

$$VZT^1 = \frac{C_A}{K_{Ao} + C_A} Z^1 T \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (25)$$

$$VZT^1 \frac{VT^1}{T} = \frac{C_A}{K_{Ao} + C_A} \frac{Z^1}{Z} = -\lambda^2 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (26)$$

$$\text{Hence } \frac{VT^1}{T} = -\lambda^2 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (27)$$

$$\frac{C_A}{K_{Ao} + C_A} Z^1 + \lambda^2 Z = 0 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (28)$$

From (27)

$$T = ACos\frac{\lambda}{V}t + B\,Sin\frac{\lambda}{V}z \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (29)$$

And (28) gives

$$T = Cs\ell^{\frac{-\lambda^2}{V}t} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (30)$$

By substituting (28) and (29) into (22) we get

$$Cs_2\left[ACos\frac{\lambda}{\sqrt{V}}t + B\,Sin\frac{\lambda}{\sqrt{V}}z\right]Cs\ell^{\frac{-\lambda^2}{\sqrt{V}}t} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (31)$$

$$Cs_o = Ac \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (32)$$

Expression in [31] and [32] shows parameters that influence the behaviour of nitrogen on the migration of salmonella in the coastal location, the expression derived through the split method techniques, the influential variables is the micropores on the formation were thoroughly expressed, this parameter is void ratio of the soil, this parameter influence the hydraulic conductivity of the formation, so the degree of void ratio in the formation determined the flow path of the formation at different strata, the expression in [31] confirmed the exponential phase of the soil micropoles, homogeneity of the formation may also be part of the influence that allowed exponential deposition of void ratio in the system , so the expression in [31] shows the relationship between the void ratio and the velocity of flow through stratification of the strata , expressing further in [32] denoted the parameters through the independed variables which is the concentration of nitrogen to be equal to degree of void ratio through the velocity of the solute.

Equation (31) becomes

$$Cs_2 = Cs_o\ell^{\frac{\frac{-\lambda^2}{C_A}t}{K_{Ao}+C_A}}\;Cos\frac{\lambda}{V}z \qquad \ldots\ldots\ldots\ldots\ldots\ldots (33)$$

Again at $\left.\frac{\partial Cs_2}{\partial t}\right|_{t\,=\,0,\;B}^{=\,0,\;z\,=\,0}$

Equation (33) becomes

$$\frac{\partial Cs_2}{\partial t} = \frac{\lambda}{V}Cs_o\ell^{\frac{\frac{-\lambda^2}{C_A}t}{K_{Ao}+C_A}}\;Sin\frac{\lambda}{V}z \qquad \ldots\ldots\ldots\ldots\ldots\ldots (34)$$

i.e. $0 = Cs_o\frac{\lambda}{\sqrt{V}}\;Sin\frac{\lambda}{V}0 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (35)$

$Cs_o\frac{\lambda}{\sqrt{V}} \neq 0$ Considering NKP

$$0 = -Cs_o \frac{\lambda}{V} \, Sin \frac{\lambda}{V} B \qquad \text{.....................} (36)$$

$$\Rightarrow \lambda = \frac{n\pi\sqrt{V}}{2} \qquad \text{.....................} (37)$$

So that equation (33) becomes

$$Cs_2 = Cs_o \, \ell^{\frac{-n^2\pi^2 V}{2\frac{C_A}{K_{Ao} + C_A}}} \, Cos \frac{n\pi\sqrt{V}}{2\sqrt{V}} z \qquad \text{.....................} (38)$$

$$Cs_2 = Cs_o \, \ell^{\frac{-n^2\pi^2 V}{2\frac{C_A}{K_{Ao} + C_A}}} \, Cos \frac{n\pi}{2} z \qquad \text{.....................} (39)$$

The expression in [36] shows the deposition of the substrate [nitrogen], this were partial deposition of nitrogen in the formation were considered, since the formation is in coastal area are homogeneous fine sand, the deposition of nitrogen were confirm to be in continuous migration, so there is no accumulation ion the surface of the soil formation, therefore partial deposition were considered in the surface of the formation, this condition influence developed model expression stated in [39].

We consider equation (6)

$$V \frac{\partial Cs_3}{\partial t} = \frac{\partial Cs_3}{\partial z} \frac{Cs}{Ks_o + Cs} \qquad \text{...........} \qquad (6)$$

We approach the system by applying Bernoulli's method of separation of variables.

$$Cs_3 = ZT \qquad \text{.....................} (40)$$

$$\frac{\partial Cs_3}{\partial t} = ZT^1 \qquad \text{.....................} (41)$$

$$\frac{\partial Cs_3}{\partial z} = Z^1 T \qquad \text{.....................} (42)$$

Again, we put (41) and (42) into (40), so that we have

$$VZT^1 = \frac{Cs}{Ks_o + Cs_3} Z^1 T \qquad \text{.....................} (43)$$

$$\text{i.e. } \frac{VT^1}{T} = \frac{Cs}{Ks_o + Cs_3} \frac{Z^1}{Z} - \lambda^2 \qquad \text{.....................} (44)$$

Hence $\frac{VT^{1}}{T} = -\lambda^{2}$ .... (45)

i.e. $\frac{Cs}{Ks_{o} + Cs} Z^{1} + \lambda^{2} z = 0$ .... (46)

From (46) $T = ACos\frac{\lambda t}{V} Z + BSin\frac{\lambda z}{V}$ .... (47)

And (46) gives

$$T = Cs_{o}\ell^{\frac{-\lambda^{2}}{V}t} \quad (48)$$

The expressed model in [48] shows the condition were the concentration are monitored in under the influence of time, the expressed model were consider the velocity of concentrations with respect to time, other influential parameters were denoted with mathematical symbolic expression, change in time of migration are influenced by high degree of void ratio through the flow path of the formation at various strata.

By substituting (47) and (48) into (40), we get

$$Cs_{3} = \left[ACos\frac{\lambda}{V} z + B\,Sin\frac{\lambda}{\sqrt{V}} z \right] Cs\ell^{\frac{-\lambda^{2}}{V}t} \quad (49)$$

Subject (54) to condition in (6) so that we have

$$Cs_{o} = Ac \quad (50)$$

$$Cs_{3} = Cs_{o}\ell\frac{-\lambda^{2}}{V}t \; Cos\frac{\lambda}{\sqrt{V}} Z \quad (51)$$

Again at $\frac{\partial Cs_{3}}{\partial t}\Big| \; t = 0, \; B$

Equation (51) becomes

$$\frac{\partial Cs_{2}}{\partial t} = \frac{\lambda}{\sqrt{V}} Cs_{o}\ell^{\frac{-\lambda^{2}}{\frac{Cs}{Ks_{o} + Cs}}} \; Sin\frac{\lambda}{V} z \quad (52)$$

i.e. $0 = -Cs_{o}\frac{\lambda}{\sqrt{V}} \; Sin\frac{\lambda}{V} 0$ .... (53)

$Cs_{o}\frac{\lambda}{\sqrt{V}} \neq 0$ Considering NKP

Which is the substrate utilization for microbial growth rate (population) so that

$$0 = -Cs_o \frac{\lambda}{V} Sin \frac{\lambda}{V} B \qquad \text{.....................} (54)$$

$$\Rightarrow \frac{\lambda}{\sqrt{V}} = \frac{n\pi}{2} \qquad \text{.....................} (55)$$

$$\Rightarrow \lambda = \frac{n\pi\sqrt{V}}{2} \qquad \text{.....................} (56)$$

So that equation (57)

$$Cs_3 = Cs_o \, \ell^{\frac{-n^2\pi^2 V}{2\frac{C_A}{K_{Ao} + C_A}}} Cos \frac{n\pi\sqrt{V}}{2\sqrt{V}} z \qquad \text{.....................} (57)$$

$$\Rightarrow Cs_3 = Cs_o \, \ell^{\frac{-n^2\pi^2 V}{2V} t} Cos \frac{n\pi}{2} z \qquad \text{.....................} (58)$$

The influential parameter increasing the depositions of salmonella transport is microelements, this parameter is the substrate utilization of the microbes , so the rate of increase are determined by the deposition of nitrogen in different formations of the soil, therefore the deposition of nitrogen are normally on the increase under the influence of the stratification variation in the coastal formations Subject to this relation, the expressed model accommodates the increase of the substrate as expressed in the stated model of [58].

Now we consider equation (8)

$$V \frac{\partial Cs_4}{\partial t} = Ds \frac{\partial Cs_4}{\partial z} \qquad \text{...........} \quad (8)$$

Using Bernoulli's method of separation of variables, we have

$$Cs_4 = ZT \qquad \text{..................} \quad (59)$$

$$\frac{\partial Cs_4}{\partial t} = ZT^1 \qquad \text{..................} \quad (60)$$

$$\frac{\partial Cs_4}{\partial Z} = Z^1 T \qquad \text{..................} \quad (61)$$

Put (60) and (61) into (8), so that we have

$$VZT^1 = -\, DsZ^1 T \qquad \text{..................} \quad (62)$$

i.e. $$\frac{VT^1}{T} = Ds \frac{Z^1}{Z} = \varphi \qquad \text{..................} \quad (63)$$

$$Ds \frac{Z^1}{Z} = \varphi \qquad \text{..................} \quad (64)$$

$$T = A\frac{\varphi}{V}z \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (65)$$

$$Z = B\ell^{\frac{-\varphi}{V}z} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (66)$$

And

Put (65) and (60) into (59), gives

$$Cs_4 = A\ell^{\frac{\varphi}{Ds}z} \bullet B\ell^{\frac{-\varphi}{Ds}z} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (67)$$

$$Cs_4 = AB\ell^{(x-t)}\frac{\varphi}{Ds} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (68)$$

Subject equation (67) to (8) yield

$$Cs_4 = (o) = C_o \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (69)$$

So that equation (69) becomes

$$Cs_4 = Cs_o\ell^{(x-t)}\frac{\varphi}{Ds} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (70)$$

The expression in [70] defined the role of void with dispersion on salmonella deposition and migration, this is through the degree of void ratio in the system, the expressed model were displayed the influence of void ratio on dispersion of salmonella in the formation, such condition were considered. To ensure that the spread of salmonella through the dispersion are determined in the expressed model the model shows the behaviour of salmonella on the deposition of nitrogen through the influence of void ration on dispersion increase..

Now, we consider equation (9)

$$V\frac{\partial Cs_5}{\partial t} = \frac{\partial Cs_5}{\partial z}q_zC_s \quad \ldots\ldots\ldots \quad (9)$$

Apply Bernoulli’s method, we have

$$Cs_5 = ZT \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (71)$$

$$\frac{\partial Cs_5}{\partial t} = ZT^1 \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (72)$$

$$\frac{\partial Cs_5}{\partial Z} = Z^1T \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (73)$$

Put (72) and (73) into (9), so that we get

$$VXT^1 = -Z^1Tq_zC_s \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (74)$$

i.e. $$\frac{VT^1}{T} = \frac{Z^1}{Z}q_zC_s = \phi \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (75)$$

$$\frac{VT^1}{T} = \phi \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (76)$$

$$\frac{Z^1}{Z} = \phi \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (77)$$

$$T \;=\; \frac{A\phi}{V} T \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (78)$$

And $$Z \;=\; B\ell \frac{-\phi}{q_z C_s} Z \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (79)$$

Put (78) and (79) into (71), gives

$$Cs_5 \;=\; A\ell^{\frac{\phi}{q_z C_s}t} \;\bullet\; B\ell^{\frac{-\phi}{q_z C_s}t} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (80)$$

$$Cs_5 \;=\; AB\ell^{(x-t)} \frac{\phi}{q_z C_s} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (81)$$

Subject equation (83) and (84) into (74) yield

$$Cs_5 \;=\; (o) \;=\; Cs_o \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (82)$$

So that equation (81) and (82) becomes

$$Cs_5 \;=\; (o) \;=\; Cs_o \;\ell^{(t-x)} \frac{\phi}{q_z C_s} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (83)$$

The expression in [83] shows the formation of the variation in stratification , this condition are were the stratification that develop various influence on the transport and deposition of nitrogen and salmonella in the coastal area under study, various influences depends on the stratification variables, the influence are expressed in terms of flow paths under the pressure of the variation deposition from degrees of void ratio in various strata, such variation in soil stratification were considered in the expression mathematically, the parameters denoted with mathematical symbols are found to establish there various function as an influence in the deposition of salmonella and nitrogen the coastal environment, the model in [83] were expressed accommodate these condition considered in the study area.

Now, we consider equation (11) which is the steady flow rate of the system

$$M_b \frac{\mu_o}{\gamma_o} \frac{\partial Cs_6}{\partial z} \;=\; \frac{\partial Cs_6}{\partial z} \frac{C_A}{K_{Ao} + C_A} \qquad \ldots\ldots\ (11)$$

Applying Bernoulli's method of separation of variables, we have

$$Cs_6 \;=\; ZT \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (84)$$

$$\frac{\partial Cs_6}{\partial t} \;=\; ZT^1 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (85)$$

$$\frac{\partial Cs_6}{\partial Z} \;=\; Z^1 T \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (86)$$

Put (85) and (86) into (11), so that we have

$$M_b \frac{\mu_o}{\gamma_o} Z^1 T \;=\; -\; \frac{C_A}{K_{Ao} + C_A} Z^1 T \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (87)$$

i.e. $$M_b \frac{\mu_o}{\gamma_o} \frac{Z^1}{Z} \;=\; \frac{C_A}{K_{Ao} + C_A} \frac{Z^1}{Z} \;=\; \alpha \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (88)$$

$$M_b \frac{\mu_o}{\gamma_o} \frac{Z^1}{Z} = \alpha \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (89)$$

$$\frac{C_A}{K_{Ao} + C_A} \frac{Z^1}{Z} = \alpha \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (90)$$

$$Z = A \frac{\alpha}{M_b \frac{\mu_o}{\gamma_o}} Z \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (91)$$

And $Z = B\ell^{\frac{\frac{\alpha}{C_A} Z}{K_{Ao} + C_A}}$ ……………… (92)

Put (91) and (92) into (84) gives

$$Cs_6 = A\ell^{\frac{\alpha}{M_b \frac{\mu_o}{\gamma_o}}} B\ell^{\frac{\alpha}{M_b \frac{\mu_o}{\gamma_o}}} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (93)$$

$$Cs_6 = AB\ell^{(x-x)} \frac{\alpha}{M_b \frac{\mu_o}{\gamma_o}} x \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (94)$$

Subject equation (93) and (94) into (94) yield

$$Cs_6 = (o) = C_o \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (95)$$

So that equation (96) becomes

$$Cs_6 = Cs_o \, \ell^{(x-x)\frac{\alpha}{M_b \frac{\mu_o}{\gamma_o}}} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (96)$$

Now, assuming that at the steady flow there is no NKP for substrate utilization, our concentration is zero so that equation (96) becomes

$$Cs_6 = 0 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (97)$$

Therefore, solution of the system is of the form

$$Cs = Cs_1 + Cs_2 + Cs_3 + Cs_4 + Cs_5 + Cs_6 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (98)$$

We now substitute (20), (39), (58), (70), (83) and (96) into (98), so that the model is of the form

$$C = Cs_o + Cs_o \, \ell \frac{-n^2\pi^2 V}{2\frac{C_A}{K_A + C_A}} Cos \frac{n\pi}{2} Z + Cs_o \, \ell \frac{-n^2\pi^2 V}{2V} \; Cos \frac{\sqrt{V}}{2} Z +$$

$$Cs_o \, \ell^{(x-t)} \frac{\phi}{Ds} + Cs_o \, \ell^{(t-x)} \frac{\phi}{q_z C_s} + Cs_o \, \ell^{(t-x)} \frac{\alpha}{M_b \frac{\mu_o}{\gamma_o}} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (99)$$

$$\boxed{\Rightarrow Cs = Cs_o \; 1 + \ell \frac{-n^2\pi^2 V}{2\frac{C_A}{K_A + C_A}} Cos \frac{n\pi}{2} + \ell \frac{-n^2\pi^2 V}{2V} + Cos \frac{n\pi}{2} +}$$

$$\ell^{(t-z)} \frac{\phi}{q_z C_s} + \ell^{(t-x)} \frac{\phi}{M_b \frac{\mu_o}{\gamma_o}} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (100)$$

The expressed model in [100] it shows case the behaviour of nitrogen on coastal formation , the substrate were able to display it role on the exponential phase of the microbes, the study were able to highlight various influence that were paramount to the migration of salmonella in coastal location These expressions were possible because the governing equation developed integrated all the required parameters that influence the deposition of nitrogen on the influence of salmonella in fine and coarse sand, such expression were through evaluate.

4. Conclusion

The behaviour of nitrogen on the influence of salmonella in coastal location has been evaluated. The study were carried to monitor the behaviour of salmonella in fresh water aquifers, several challenges are found to deposit in coastal aquifer under the influence of homogeneous stratification, this concept were to determine the variation distribution in the microbes under the influence of formation variables in the study location. The study developed governing equation that will monitor the system in this direction, the governing were derived in phase according to the behaviour of the microbes including the rate of nitrogen deposition in coastal location. The expressed model were develop and finally identified all the variables that influence various condition considered in the study, the model if applied will definitely monitor the behaviour microbes and also determine the rate of concentration at various formation in the study locations.

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