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Research article

MASS RATE OF SHIGELLAE TRANSPORT INFLUENCED BY DISPERSION AND PERMEABILITY IN LATERITIC AND SILTY FORMATION IN BUGUMA, RIVERS STATE OF NIGERIA

Eluozo, S. N

[1]Subaka Nigeria Limited, Port Harcourt, Rivers State of Nigeria
Director & Principal Consultant, Civil & Environmental Engineering,
Research & Development
E-mail: Soloeluozo2013@hotmail.com
E-mail: solomoneluozo2000@yahoo.com

Abstract

Developing a system through modified governing equation was necessary to generate model that will monitor mass transport rate of Shigellae in the study area. Such condition express the deposition variation of Shigellae in various strata, the derived model equation express some of influential parameters in the system from formation characteristics that determine the mass rate of Shigellae transport in the study location. The concept were to determine various influences from formation characteristics that can cause the accumulation or migration of Shigellae in soil formation, dispersion of Shigellae was investigated to develop its rates of spread in some of the study location through the deposition of high degree of permeability, these expressions developed a significant influences to monitor the mass transport of Shigellae in the study area. To determine various rate of Shigellae deposition within lateritic and silty formation, mathematical model were found suitable to sequentially express various condition of mass transport in lateritic and silty formation the study will definitely defined a base line that can evaluating the deposition of Shigellae in coastal area of Buguma.

Keywords: mass Shigellae transport, dispersion, lateritic and silty formation

1. Introduction

The intention of coastal aquifer management is the same as for other aquifer systems – to achieve a sustainable use of groundwater, coordinated with the use of other water resources, to meet part of the demand for water by supplying water of adequate quality, in the place at the right time, respecting environmental and habitat restrictions [Custodio, 2005]. The main additional items to be considered are the risk of salinization and water quality degradation in relation with possible accumulation of manmade contaminants in areas of low hydraulic gradient and flow pattern forming a closed area due to groundwater abstraction conditions [Arbam 1999]. Often these risks do not result in immediate threats, but the results may be delayed for a long time. This means that coastal aquifer management should rely on conservation and protection measures [Schiedeger and lindinger, 2004, Omotsola and Adegoke, 1981, Eluozo and Nwaoburu 2013]. Coastal groundwater resources are increasingly a critical component of available freshwater in Nigeria, in a national setting of rising population density in coastal margins. The enhanced dependency on coastal groundwater has resulted in symptoms of over-extraction, namely seawater intrusion (i.e., the landward encroachment of saline groundwater). The seawater intrusion threat to freshwater supplies has already led to groundwater management response in some regions of Nigeria, with extensive investigation and the construction of monitoring boreholes. Coastal aquifer management in Nigeria needs to account not only for existing threats to freshwater resources and groundwater-dependent ecosystems but also for the influences of climate change which is expected to produce modified groundwater recharge and rising ocean levels. Effective coastal management must be based on a solid scientific foundation, taking into account the limitations of natural systems, while balancing and integrating the demands of the various sectors which depend on these systems for their livelihood The coastline of Nigeria is about 1000km long on the Gulf of Guinea, bordering eight states of Lagos, Ogun, Ondo, Delta, Bayelsa, Rivers, Akwa Ibom and Cross River. While the first four states are west of the River Niger, the last three states are east of the Niger with the last, Bayelsa State, straddling the river. Geologically, Coastal Nigeria is covered by two sedimentary basins, the Keta basin and Niger Delta basin. The Keta basin (also called the Benin- or Dahomey basin in Nigerian literature) is a transboundary basin that extends from Ghana through Togo and Benin to Nigeria. The Niger Delta basin is separated by the Okitipupa Ridge [Hudake,1999]. The Keta Basin constitutes part of a system of West African margin developed during a brief period of rifting in the late Jurassic to Early Cretaceous, associated with the Benin Trough Complex. It was accompanied by an extended period of thermally induced basin subsidence through the Middle to Upper Cretaceous to Tertiary times as the South American and African plate entered a drift phase. The onshore portion of the basin covers a broad arc-shaped profile approximately 600km2, attaining a maximum width of 65km at the basin axis along the Nigerian border with the Republic of Benin. It narrows to about 25km west and eastwards. It is along its north eastern fringe (the Okitipupa Structure) that a band of tar sand (oil sand) and bitumen seepage occurs [Moline,et al 1998, Hudak,1999]. A quantity of text materials exist on diverse processes of proper sitting of monitoring wells based on the character of groundwater flow, and dimensions of the polluted field. [Moline et al, 1988 Eluozo and Nwaoburu 2013] Devised a graphical heuristic for locating up gradient groundwater monitoring wells near landfills, and observed that it can be adapted to no homogeneous flow fields, heterogeneous transport limitations, and irregularly shaped landfills oriented at various angles to the direction of groundwater flow. [Hudak,2001] observed that the need for satisfactory characterization of spatial and temporal variations of groundwater flow are for suitable position and construction of monitoring wells, timing of ground water monitoring, and evaluation of exposure risk and contaminant flux in support of remedial decision-making.

[Macdonald and hurbough, 1988]. observed that heterogeneous network, groundwater monitoring wells clustered near the down-gradient corner of a landfill registered 100% detection efficiency. This strategy was effective because the cut-off wall induced convergent groundwater flow beneath the landfill. This study suggests that distorted hydraulic head fields induced by partial cut-off walls will be considered when designing detection monitoring networks at landfills. Advances in numerical modeling software such as MODFLOW [Nwachukwu and Alinor, 2002] has simplified the study of groundwater flow, which in this paper is been extended to selecting sites for groundwater quality monitoring wells. Spilling the occupational wastes of mechanics on the ground has been a common practice in the region for over 25 years [Ibe and Njoku, 1999]. There is no enforced regulation for the disposal of municipal solid waste and sewage. Solid waste is disposed of by open dumping at several locations [Ibe and Njoku, 1999, ibe,et al 2007,]. Sewage evacuated from soak-away pits present in virtually every household, is mixed with soil, and used as manure on farm lands around the southwest flank in the area.

2. Theoretical background

The depositions of Shigellae were found to be predominant in every part of coastal environment, Buguma precisely through indiscriminate dumping of biological waste in the study area. The study location are situated at the coastal location, the settlers could not understand the rate of transport of this type of contaminant until ground water investigations were carried out, only to find out that such deposited microbes has polluted ground water at shallow deposition. The rate of dispersion is the focus of the study, because the rate of Shigellae deposition has been influenced by some formation characteristic in the formation, the investigation done were able to analyzed it rate of deposition, but the cause of dispersion to some part of the study area could not be known for now, base on these conditions fine it necessary to engineer out this microbes, this implies that there should be some baseline that will improve engineering out of the contaminant at any area it is found in the coastal area of Buguma, the influence from formation characteristics such as degree of permeability will be expressed, this parameter determine the permeable condition, the formation setting determine the degree of permeability that influences mass rate of Shigellae in coastal area of Buguma, mass rate of solute Shigellae are base on the formation variation of the study location. Dispersion of Shigellae is from high degree of permeability that have spread some large region of the study area, the approach will establish a better solution that will monitor the rate of mass transport of Shigellae in the study location.

3. Governing equation

$$K\frac{\partial q}{\partial t} = D(x)\frac{\partial^2 q}{\partial x^2} - V\frac{\partial q}{\partial x} - \frac{\partial q\mu(x)}{\partial t} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

The establishment of the governing equation for the study of mass transport of Shigellae were found necessary due to it rate of pollution in lateritic and silty formation, the study that generate this governing equation is imperative because the accumulation of Shigellae in lateritic and silty formation implies that there a tendency of migrating above two sample formation even if there degree of permeability may appear to be very low, other environmental influences like climatic condition in the deltaic environment may influence the increase of permeability through high rain intensities. The governing equation developed integrated most the stated conditions in the generated equation,

Nomenclature

q = Mass Rate of Transport of Shigellae $[LT^{-1}]$

D = Dispersion coefficient in longitudinal location (MT^{-1})

μ(x) = Loss coefficient at location of x LT^{-I}

V = Velocity of flow $[LT^{-I}]$

T = Time [T]

X = Distance [M]

V = Void ratio [-]

$$K\frac{\partial^2 q_1}{\partial t} = D(x)\frac{\partial^2 q_1}{\partial x^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

$$\left.\begin{array}{l} t = 0 \\ x = 0 \\ C_{(o)} = 0 \\ \left.\dfrac{\partial C}{\partial t}\right|_{t = 0, B} = 0 \end{array}\right\} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

$$K\frac{\partial q_2}{\partial t} = V(x)\frac{\partial q^2}{\partial x} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (4)$$

$$\left.\begin{array}{l} t = 0 \\ x = 0 \\ q_{(o)} = 0 \\ \left.\dfrac{\partial q}{\partial t}\right|_{t = 0,\ B} \end{array}\right\} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (5)$$

$$V\frac{\partial q_3}{\partial t} = -\frac{\partial q_3 \mu(x)}{\partial t} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (6)$$

$$\left.\begin{array}{l} t = 0 \\ C_{(o)} = 0 \end{array}\right\} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (7)$$

$$\left.\frac{\partial q_3}{\partial t}\right|_{t\,=\,0,\ B} = 0$$

$$K\frac{\partial q_4}{\partial x} - \frac{\partial q_4 \mu c}{\partial t} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (8)$$

$x = 0$

$t = 0$

$$C_{(o)} = 0 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (9)$$

$$\left.\frac{\partial C_4}{\partial x}\right|_{x\,=\,0,\ B} = 0$$

$$D(x)\frac{\partial^2 q_5}{\partial x^2} - V\frac{\partial q_5}{\partial x} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (10)$$

$x = 0$

$$q_{(o)} = 0 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (11)$$

$$\left.\frac{\partial q_5}{\partial x}\right|_{x\,=\,0,\ B}$$

Applying direct integration on (2)

$$K\frac{\partial q_1}{\partial t} = D(x)q + K_1 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad .(12)$$

Again, integrate equation (12) directly yield

$$Kq = D(x)qt + Kt + K_2 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (13)$$

Subject to equation (3), we have

$$Kq_o = K_2 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (14)$$

And subjecting equation (12) to (3) we have

At $\left.\frac{\partial q_1}{\partial t}\right|_{t\,=\,0} = 0 \quad q(o) = qo$

Yield

$$0 = D(x)q_o + K_2$$

$$\Rightarrow V_1 = D(x)q_o = K_2 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (15)$$

So that we put (13) and (14) into (13), we have

$$Kq_1 = D(x)q_{1t} - D(x)qox\,Vqo \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (16)$$

$$Kq_1 - D(x)q_{1x} = Vq_o - D(x)qox \qquad \ldots\ldots\ldots\ldots \qquad (17)$$

$$q_1 = q_o \qquad \ldots\ldots\ldots\ldots \qquad (18)$$

Hence equation (18) entails that at any given distance x, we have constant concentration of the contaminant in the system

The expression from the derived solution considered change in concentration from lateritic to silty formation, the degree of permeability of the microbes Cannot be compared with the lateritic soil formation where permeability is very low, there will high rate of accumulation, but for deltaic influences on the formation there is a high tendency of changing in concentration with respect to distance stated in equation [18]

$$K\frac{\partial q_2}{\partial t} = -V\frac{\partial q^2}{\partial x} \qquad \ldots\ldots\ldots\ldots \qquad (4)$$

We approach the system, by using the Bernoulli's method of separation of variables

$$q_2 = XT \qquad \ldots\ldots\ldots\ldots \qquad (19)$$

i.e. $$K\frac{\partial q_2}{\partial t} = XT^1 \qquad \ldots\ldots\ldots\ldots \qquad (20)$$

$$K\frac{\partial q_2}{\partial x} = X^1T \qquad \ldots\ldots\ldots\ldots \qquad (21)$$

Put (20) and (21) into (19), so that we have

$$KXT^1 = -KX^1T \qquad \ldots\ldots\ldots\ldots \qquad (22)$$

i.e. $$K\frac{T^1}{T} = K\frac{X^1}{X} = -\lambda^2 \qquad \ldots\ldots\ldots\ldots \qquad (23)$$

Hence $$K\frac{T^1}{T} + \lambda^2 = 0 \qquad \ldots\ldots\ldots\ldots \qquad (24)$$

i.e. $$X^1 + \frac{\lambda}{R}x = 0 \qquad \ldots\ldots\ldots\ldots \qquad (25)$$

$$KX^1 + \lambda^2 X = 0 \qquad \ldots\ldots\ldots\ldots \qquad (26)$$

From (25), $$X = ACos\frac{\lambda}{K}X + BSin\frac{\lambda}{\sqrt{K}}X \qquad \ldots\ldots\ldots\ldots \qquad (27)$$

And (20) gives

$$T = C\ell^{\frac{-\lambda^2}{K}t} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (28)$$

And (20) gives

$$C_2 = \left(ACos\frac{\lambda}{K}t + BSin\frac{\lambda}{\sqrt{K}}t \right) C\ell^{\frac{-\lambda^2}{K}x} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (29)$$

Subject to equation (29) to conditions in (5), so that we have

$$q_o = AC \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (30)$$

Equation (30) becomes

$$q_2 = q_o \ell^{\frac{-\lambda^2}{V}x} Cos\frac{\lambda}{\sqrt{K}}{}^{t} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (31)$$

Again, at

$$\left.\frac{\partial q_2}{\partial t}\right|_{t = 0,\ B} = 0,\ x = 0$$

Equation (31) becomes

$$\frac{\partial q_2}{\partial t} = \frac{\lambda}{\sqrt{K}} q_o \ell^{\frac{-\lambda}{V}x} Sin\frac{\lambda}{\sqrt{K}}t \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (32)$$

i.e. $0 = -\frac{qo\lambda}{\sqrt{K}} Sin\frac{\lambda}{K}0$

$Co\frac{\lambda}{V} \neq 0$ Considering NKP

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

$$0 = qo\frac{\lambda}{\sqrt{K}} Sin\frac{\lambda}{\sqrt{K}}B \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (33)$$

$$\Rightarrow \frac{\lambda}{K} = \frac{n\pi}{2}n,1,2,3 \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (34)$$

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$$\Rightarrow \lambda = \frac{\lambda}{V} = \frac{n\pi\sqrt{R}}{2} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (35)$$

So that equation (31) becomes

$$\Rightarrow q_2 = qo\ell \frac{-n^2\pi^2K}{2} t \; Cos \frac{n\pi\sqrt{K}}{2\sqrt{K}} x \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (36)$$

$$\Rightarrow q_2 = qo\ell \frac{-n^2\pi^2K}{2} t \; Cos \frac{n\pi}{2} x \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (37)$$

Now, we consider equation (7), we have the same similar condition with respect to the behaviour

$$K \frac{\partial q_3}{\partial t} = -\frac{\partial q_3 \mu(x) q}{\partial t} \qquad \ldots\ldots\ldots\ldots\ldots \qquad (6)$$

$$q_3 = XT^1 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (38)$$

$$\frac{\partial q_3}{\partial t} = XT^1 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (39)$$

i.e. $K \frac{\partial q_3}{\partial t} = XT^1 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (40)$

Put (20) and (21) into (19), so that we have

$$KXT^1 = -XT^1 \mu(x) q \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (41)$$

i.e. $K \frac{T^1}{T} = -\frac{T^1}{T} \mu(x) q - \lambda^2 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (42)$

$$K \frac{T^1}{T} + \lambda^2 = 0 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (43)$$

$$X^{1} + -\frac{\lambda}{K}t = 0 \qquad \text{.............................} \qquad (44)$$

And $VT^{1} + \lambda^{2}t = 0$ .... (45)

From (44), $t = A\,Cos\,\frac{\lambda}{K}t + B\,Sin\,\frac{\lambda}{\sqrt{K}}t$ .... (46)

and (39) give

$$T = q\,\ell\,\frac{-\lambda^{2}}{\mu(x)q}t \qquad \text{.............................} \qquad (47)$$

By substituting (46) and (47) into (38), we get

$$C_{3} = \left(A\,Cos\,\frac{\lambda}{K}t + B\,Sin\,\frac{\lambda}{K}t\right)C\,\ell\,\frac{-\lambda^{2}}{\mu(x)q}t \qquad \text{.................} \qquad (48)$$

Subject equation (48) to conditions in (7), so that we have

$$qo = AC \qquad \text{.............................} \qquad (49)$$

Equation (49) becomes

$$q_{3} = qo\,\ell\,\frac{-\lambda^{2}}{\mu(x)q}t\;Cos\,\frac{\lambda}{q}t \qquad \text{.............................} \qquad (49)$$

Again, at $\left.\frac{\partial q_{3}}{\partial t}\right|_{t\,=\,0,B} = 0 \quad t = 0$

Equation (50) becomes

$$\frac{\partial q_3}{\partial t} = \frac{\lambda}{K} Co \ell \frac{-\lambda}{\mu(x)q} t \; Sin \frac{\lambda}{K} t \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (51)$$

i.e. $0 = qo\frac{\lambda}{V} \; Sin \frac{\lambda}{V} 0$

$qo\frac{\lambda}{K} \neq 0$ Considering NKP again

Due to the rate of growth, which is known to be the substrate utilization of the microbes we have

$$0 = -qo\frac{\lambda}{\sqrt{K}} \; Sin \frac{\lambda}{\sqrt{K}} B \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. \qquad (52)$$

There is the tendency of microelements deposition in Buguma because the rates of Shigellae deposition are observed to deposit high percentage. The increase of microbial population were examine, this implies that there high deposition of microelements in the formation, the dimension of considering micronutrients is very essentials because the increase of microbial population depends on the these mineral, the deposition of formations characteristics such as permeability will definitely ease the migration of manmade microelement to integrate with the natural deposited one and finally developed more Shigellae in the study area. The degrees of mass transport of Shigellae in the coastal environments are found to be at high percent.

$$\Rightarrow \frac{\lambda}{K} = \frac{n\pi}{2} n, 1, 2, 3 \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. \qquad (53)$$

$$\Rightarrow \lambda = \frac{n\pi\sqrt{R}}{2} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. \qquad (54)$$

So that equation (50) becomes

$$q_3 = qo \ell \frac{-n^2\pi^2 R}{2\mu(x)q} t \; Cos \frac{n\pi}{2} t \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. \qquad (55)$$

Now, we consider equation (8), we have

$$V \frac{\partial q_4}{\partial x} - \frac{\partial q_4 \mu(x) q}{\partial x} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (8)$$

Using Bernoulli's method, we have

$$C_4 = XT \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (56)$$

$$\frac{\partial q_4}{\partial x} = X^1 T \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (57)$$

$$\frac{\partial C_4}{\partial t} = X^1 T \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (58)$$

Put (57) and (58) into (56), so that we have

$$VX^1 T = -X^1 T \ \mu(x) X^1 T \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (59)$$

i.e. $V \frac{X^1}{X} = -\frac{X^1}{X} \mu(x)$ …………………… (60)

$$V \frac{X^1}{X} = \varphi \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (61)$$

$$\frac{X^1}{X} \mu(x) q = \varphi \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (62)$$

$$X = A \ell \frac{\varphi}{V} x \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (63)$$

Put (62) and (63) into (56), gives

$$C_4 = A \ell \frac{\varphi}{\mu(x)} \bullet B \ell \frac{-\varphi}{\mu(x)} x \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (64)$$

$$C_4 = AB\,\ell^{(t-x)}\frac{\varphi}{\mu(x)} \qquad \text{..............................} \qquad (65)$$

Subject equation (66) to (8)

$$q_4\ (o) = qo \qquad \text{..............................} \qquad (66)$$

So that equation (67) becomes

$$\boxed{q_4 = qo\,\ell^{(t-x)}\frac{\varphi}{\mu(x)q}} \qquad \text{..............................} \qquad (67)$$

Considering equation (10), we have

$$D(x)\frac{\partial^2 q_5}{\partial x^2} - V\frac{\partial q_5}{\partial x} \qquad \text{....................} \ (10)$$

$$q_5 = X^{11}T \qquad \text{..............................} \qquad (68)$$

$$\frac{\partial^2 C_5}{\partial x^2} + X^{11}T \qquad \text{..............................} \qquad (69)$$

$$\frac{\partial q_5}{\partial x} + X^1 T \qquad \text{..............................} \qquad (70)$$

Put (69) and (70), so that we have

$$D(x)X^{11}T - VX^1T \qquad \text{..............................} \qquad (71)$$

$$D(x)\frac{X^{11}}{X}T - V\frac{X^1}{X} \qquad \text{..............................} \qquad (72)$$

$$D(x)\frac{X^{11}}{X} = \varphi \qquad \text{..............................} \qquad (73)$$

$$V\frac{X^1}{X} = \varphi \quad \text{.............................. (74)}$$

$$X^1 = A\ell \frac{\varphi}{D(x)}x \quad \text{.............................. (75)}$$

Put (74) and (75) into (68), gives

$$q_5 = A\ell \frac{\varphi}{V} \bullet B\ell \frac{-\varphi}{V}x \quad \text{.............................. (76)}$$

$$q_5 = AB\ell^{(x-x)}\frac{\varphi}{V} \quad \text{.............................. (77)}$$

Subject (76) to (10)

$$q_5 \ (o) = Co \quad \text{.............................. (78)}$$

So that equation (78) becomes

$$q_5 = qo\,\ell^{(x-x)}\frac{\varphi}{V} \quad \text{.............................. (79)}$$

Now, assuming that at the steady flow, there is no NKP for substrate utilization, our concentration here is zero, so that equation (79) becomes

$$q_5 = 0 \quad \text{.............................. (80)}$$

The expression in equation [80] shows lots of conditions where there may be no deposit of substrate deposition in the formation, the condition of high degree of temperature that will not be comfortable for the microbes can play some roles at these stages thus generate degradation of the contaminant. The study location deposition ground water at shallow aquifer depths as observed at desk studies , these conditions are very clear in transport system because the temperature are very high, the migration of Shigellae population will experiences degradation. Therefore the expressed derived solution considered these conditions at various dimensions.

Therefore, $C_1 + C_2 + C_3 + C_4 + C_5$ .... (81)

We now substitute (18), (37), (55), (67) into (81) so that we have the model of the form

$$q = qo + qo\ell \frac{-n^2\pi^2 R}{2K} x \, Cos\frac{n\pi}{2} t \bullet Co\ell \frac{-n^2\pi^2 R}{2\mu(x)} t \, Cos\frac{n\pi}{2} t +$$

$$qo\ell^{(t-x)} \frac{\varphi}{\mu C} \qquad \text{.............................} \qquad (82)$$

$$\Rightarrow q = qo + 1 + \ell \frac{n^2\pi^2 K}{2K} x \, Cos\frac{n\pi}{2} \bullet Co\ell \frac{-n^2\pi^2 K}{2\mu(x)} t \, Cos\frac{n\pi}{2} t +$$

$$Co\ell^{(t-x)} \frac{\varphi}{\mu(x)} \qquad \text{.............................} \qquad (83)$$

The express derived model [83] are base on the parameters that were found significant in the system, this developed governing equation were modified to fit the condition that will express the rate of Shigellae transport in coastal and upland area of deltaic environments, the derived model are developed to ensure that the variation due to environmental challenges are integrated in the derived model expression, such condition are not peculiar in the study area due to high degree of permeability found to deposit in coastal environment as stated by the desk studies.

4. Conclusion

Modeling Shigellae mass transport rate in coastal area of Buguma defined the environmental established influences in the environments, the developed governing equation produced a model that consider lots of influential parameters in the developed system, this is to ensure that various condition developed increase and decrease of Shigellae population are integrated in the system, the most influential parameter that played major roles is the permeability of the soil between the lateritic and silty formation, though the permeability coefficient are very low as compare to silty sample, but the reason is to note the accumulated region of Shigellae concentration in the study area, this is to determine the most mass rate of Shigellae are observed in the system, these established condition predict the rate of Shigellae migration above the silty formation, several studies has been done in batch application of monitoring the microbes, but few has only been carried out in the application of plug flow were more than one sample soil are investigated on the transport process on these two parameters . This study has thorough observe all challenging defined in coastal environment, there need to monitor these parameters considering these stated conditions.

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