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Research article

PREDICTIVE MODEL TO MONITOR THE DEPOSITION OF NITROGEN AND ARSENIC ON EDWARDSIELLA TRANSPORT IN HOMOGENOUS GRAVEL FORMATION IN COASTAL AREA OF ABOLUMA, NIGER DELTA OF NIGERIA

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Abstract

Deposition of nitrogen and arsenic has seen examined in homogenous gravel formation, the study were to monitor the influences on the migration process of Edwardsiella in uniform velocity of flow, dispersion influences were found to developed spread in some region of the study location, such formation characteristics has developed physiochemical reaction whereby the deposition and migration experiences fluctuation in concentration and deposition at different formation of the strata, the study examine these factors and develop a system that produces governing equation to predict and monitor these contaminant, their reactions at different strata in the study location were examined to be influenced by other factors such climatic influences of deltaic environment, the study is imperative because it has defined the physiochemical reaction base of the depositions of arsenic and nitrogen influencing migration of Edwardsiella in the study area.

Keywords: predictive model, arsenic, nitrogen, Edwardsiella transport and gravel formation

1. Introduction

Overall toxic effects of heavy metals to soil microorganisms depend on their bioavailability. Although, heavy metals bio availabilities is mainly dependents on the soil properties (pH and organic matter), Bacteria can also directly influence the solubility of heavy metals, by altering their chemical properties. (Okpokwasili 2005).

Investigation conducted revealed that microorganisms have developed several mechanisms which can immobilize, mobilize or transform heavy metals from one region to another. These processes include extracellular precipitation, intracellular accumulation, oxidation and reduction reactions, methylation and demethylation, and extracellular binding and complexation. The exploitation of these bacterial properties for the remediation of heavy metal-contaminated sites has been shown to be a promising bioremediation alternative. However, at high concentrations, bio available heavy metals are toxic for a great number of soil microorganisms and soil microbial processes which in turn will result in severe ecosystem disturbance (Rabia, 2007). The deleterious effects of heavy metals on microbe-mediated processes have been discussed in detail in several publications. Generally, a decrease in carbon mineralization and fixation, in nitrogen transformation, soil enzyme activities and litter decomposition can be observed. Other typical effects of heavy metal contamination are a decrease in the microbial numbers (CFU), biomass, or an increase of the frequency of heavy metal resistant bacteria (Fablemne, 2003). However, measuring these parameters is not suitable for the determination of changes in the entire structure of soil communities exposed to pollutants. Since many of the microbiological and biochemical techniques used to study the effects of heavy metals on soil bacteria are cultivation dependent, they do not provide detailed information on the non-cultivable bacteria, neglecting thus the major part of the soil microbial community. Consequently, soil microbial communities are treated as a black box (Gikas et al; 2009). These limitations have been overcome by the recent advances in molecular fingerprinting methods. Based on the analyses of signature biomarkers such as phospholipids fatty acids or nucleic acids, the fingerprinting techniques have been used as reported by (Fablemne, 2003). Chromium is found in many environments, including air, water, soil and all biota. It ranks 21st among the elements in crustal abundance (Ahmed et al; 2003). The average concentration of chromium in the continental crust has been reported as 125 mg/kg (National Academy of Science (NAS), 1974). Concentrations in freshwater generally range from 0.1 to 6.0 μg/L with an average of 1.0 μg/L, while values for seawater average 0.3 μg/L and range from 0.2 to 50 μg/L (Bowen, 1979). Freshwater chromium concentrations are dependent on soil chromium levels in the surrounding watershed areas. In addition, drainage water from irrigated agricultural areas with elevated amounts of soil chromium levels can have high chromium concentrations (as high as 800 μg/L), as observed at various locations within San Joaquin Valley (Deveral et al; 1984; Gaines, 1988). Chromium is extracted from chromite ore [(Fe, Mg)O(Cr, Al, Fe) O] that has largest deposits in South Africa, the Philippines, Southern Zimbabwe, and Turkey (Rathnayake et al; 2010 Eluozo et al 2013). The major users of chromium are the metallurgical, chemical, and refractory brick industries. Other industries that employ chromium include pigment manufacture, metal finishing, corrosion inhibition, organic synthesis, leather tanning, and wood preservation. Extensive industrial usage of chromium leads to generation of large volumes of chromium-containing wastes that are discharged into the environment. In addition to this waste, leakage due to improper handling and faulty storage containers also adds to the accumulation of chromium in the environment. Chromium is one of those heavy metals the concentration of which is steadily increasing due to industrial growth, especially the development of metal, chemical and tanning industries Natural sources as well as the anthropogenic sources account for this contamination, which has become a threat to public health. Cadmium, copper and zinc are among those heavy metals that are being released to the environment (Wyzkoska, 2002). These heavy metals influence the microbial population by affecting their growth, morphology, biochemical activities and ultimately resulting in decreased biomass and diversity. The ability of an organism to survive in an environment with high metal concentration or its capacity to accumulate high concentration of heavy metal without dying reflects its capacity to tolerate metals (Azza et al; 2009). Heavy metals have been reported to be powerful inhibitors of biodegradation activities (El. Deeb and Altalhi, 2009 Eluozo et al 2013). The development and biochemical activities of soil micro-organisms undergo several alterations. To prevent negative ecological consequences, microbiologically-related parameters should be involved in the indication of soil quality (Anyanwu and Ugwu, 2010). At low concentrations, metals can serve as important components in life processes, often serving important functions in enzyme productivity. However, above certain threshold concentrations, metals can become toxic to many species. Fortunately, microorganisms can affect the reactivity and mobility of metals. Microorganisms that affect the reactivity and mobility of metals can be used to detoxify some metals and prevent further metal contamination (Smejkalovs et al; 2003 Eluozo et al 2013)

2. Theoretical background

Edwardsiella transport has been of serious threat to settler in the study area, so many formation characteristics influences in the study location, this pollution source were found to be predominant in the coastal location, more so the deposition of arsenic and nitrogen were also found to deposit in some part of the region of the study area. There are tendency Physiochemical interactions in the region of the soil, because lots of these pollutants are found to deposit in the same formation. The migration of these contaminants are determined by several formation influences such as percentage of void ratio and dispersion rate in the formation, these formation characteristics were investigated during risk assessment carried out for ground water, several relevant analysis were done to produces these results on the deposition of arsenic and nitrogen including the deposition of Edwardsiella in the study location. The study will ensure that the reaction with other physiochemical deposition are thoroughly examined in the study area, this condition will be expressed in the study through the system that will be formulated, the developed system will produced governing equation that will be derived to develop model for the study.

Governing equation

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

Equation (1) expressed an application of determining the physiochemical reactions interacting with nitrogen and arsenic on Edwardsiella transport in homogeneous gravel formations. Mathematical equations were developed denoted by mathematical symbols expressing the parameters as presented above. Physical split techniques were applied that descretize the variables to express their thorough functions in the system. Introducing the splitting application is denoted with mathematical tools.

World Open Journal of Environmental Engineering
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$$V\frac{\partial Cs_1}{\partial t} = M_b\frac{\mu_o}{\gamma_o}\frac{\partial Cs_1}{\partial z} \qquad \text{(2)}$$

$$\left.\begin{array}{l} x = 0 \\ Cs_{(o)} = 0 \\ \frac{\partial Cs_1}{\partial t}\Big| t = 0,\ B \end{array}\right\} \qquad \text{(3)}$$

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

$$\left.\begin{array}{l} x = 0 \\ t = 0 \\ Cs_{(o)} = 0 \\ \frac{\partial Cs_2}{\partial t}\Big| t = 0,\ B \end{array}\right\} \qquad \text{(5)}$$

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

$$\left.\begin{array}{l} t = 0 \\ Cs_{(o)} = 0 \\ \frac{\partial Cs_3}{\partial t}\Big| t = 0,\ B \end{array}\right\} \qquad \text{(7)}$$

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

$$\left.\begin{array}{l} t = 0 \\ x = 0 \\ Cs_{(o)} = 0 \\ \frac{\partial Cs_4}{\partial t}\Big| t = 0,\ B \end{array}\right\} \qquad \text{(9)}$$

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

$$\left.\begin{array}{l} t = 0 \\ x = 0 \\ Cs_{(o)} = 0 \end{array}\right\} \qquad \text{(11)}$$

$$\frac{\partial Cs_5}{\partial t} \Big| t = 0, B$$

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

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

Applying direct integration on (2)

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

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)

At $\left. \frac{\partial Cs_1}{\partial t} \right| \begin{array}{l} = 0 \;\; Cs_{(o)} = Cs_o \\ t = 0 \end{array}$

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

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

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

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

World Open Journal of Environmental Engineering
Vol. 1, No. 1, November 2013, PP: 26 - 40
Available online at http://scitecpub.com/Journals.php

$$\Rightarrow Cst = Cs_o \qquad \text{..................} \qquad (21)$$

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

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

i.e. $Cs_2 = ZT$ .... (22)

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

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

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

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

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

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

Hence

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

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

From (27)

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

And (28) gives

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

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

$$Cs_o = Ac \qquad \text{.....................} \; (36)$$

The expression here from equation [4] explain the deposition of the contaminants to be in exponential sage on the transport system, the rate of void ratio in the formation are influenced by velocity of flow, such condition shows how the migration process are generating fast migration in this stage, the developed model in [31] express these conditions as it is considered to behave develop variations at these stage of the transport process, the established condition at these phase express the derived solution to developed a model considering this phase of the transport system.

Equation (31) becomes

World Open Journal of Environmental Engineering
Vol. 1, No. 1, November 2013, PP: 26 - 40
Available online at http://scitecpub.com/Journals.php

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

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

Equation (33) becomes

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

i.e. $0 = Cs_o \frac{\lambda}{\sqrt{V}} Sin \frac{\lambda}{V} 0$ .... (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

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

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

We consider equation (6)

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

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

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

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

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

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

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

And (46) gives

$$T = Cs_o \ell^{\frac{-\lambda^2}{V}t} \qquad \text{.................... (48)}$$

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

$$Cs_3 = \left[ACos\frac{\lambda}{V} z + BSin\frac{\lambda}{\sqrt{V}} z \right] Cs \ell^{\frac{-\lambda^2}{V}t} \qquad \text{.................... (49)}$$

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

$$Cs_o = Ac \qquad \text{.................... (50)}$$

$$Cs_3 = Cs_o \ell \frac{-\lambda^2}{V} t \; Cos\frac{\lambda}{\sqrt{V}} Z \qquad \text{.................... (51)}$$

$$\text{Again at } \left.\frac{\partial Cs_3}{\partial t}\right| \; t = 0, \; B$$

Equation (51) becomes

World Open Journal of Environmental Engineering
Vol. 1, No. 1, November 2013, PP: 26 - 40
Available online at http://scitecpub.com/Journals.php

$$\frac{\partial Cs_2}{\partial t} = \frac{\lambda}{\sqrt{V}} Cs_o \ell^{\frac{-\lambda^2}{\frac{Cs}{Ks_o + Cs}}} Sin \frac{\lambda}{V} z \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (52)$$

i.e. $0 = -Cs_o \frac{\lambda}{\sqrt{V}} Sin \frac{\lambda}{V} 0 \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (53)$

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

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

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

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

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

So that equation (57)

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

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

The study are to interact with several deposited physiochemical parameter in the formations, such condition were expressed in the derived solution, nitrogen is one of the substrate in the system, consideration of several substrate stated in the above equation are base on the rate of deposition of substrate found in any region of the strata. These expression implies that the deposition of nitrogen are in heterogeneous state on the soil formation, therefore the expression were monitor in such condition as it is expressed mathematically at different stages.

Now we consider equation (8)

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

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

$$Cs_4 = ZT \qquad \ldots\ldots\ldots\ldots\ldots\ldots (59)$$

World Open Journal of Environmental Engineering
Vol. 1, No. 1, November 2013, PP: 26 - 40
Available online at http://scitecpub.com/Journals.php

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

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

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

$$VZT^1 = -DsZ^1T \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (62)$$

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

$$Ds\frac{Z^1}{Z} = \varphi \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (64)$$

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

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

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

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

Now, we consider equation (9)

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

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

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

World Open Journal of Environmental Engineering
Vol. 1, No. 1, November 2013, PP: 26 - 40
Available online at http://scitecpub.com/Journals.php

i.e. $\frac{VT^1}{T} = \frac{Z^1}{Z} q_z C_s = \phi$ ……………… (75)

$$\frac{VT^1}{T} = \phi \qquad \text{………………} \quad (76)$$

$$\frac{Z^1}{Z} = \phi \qquad \text{………………} \quad (77)$$

$$T = \frac{A\phi}{V} T \qquad \text{………………} \quad (78)$$

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

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

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

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

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

$$Cs_5 = (o) = Cs_o \qquad \text{………………} \quad (82)$$

So that equation (81) and (82) becomes

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

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

$$M_b \frac{\mu_o}{\gamma_o} \frac{\partial Cs_6}{\partial z} = \frac{\partial Cs_6}{\partial z} \frac{C_A}{K_{Ao} + C_A} \qquad \text{…….} \quad (11)$$

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

$$Cs_6 = ZT \qquad \text{………………} \quad (84)$$

$$\frac{\partial Cs_6}{\partial t} = ZT^1 \qquad \text{………………} \quad (85)$$

$$\frac{\partial Cs_6}{\partial Z} = Z^1 T \qquad \text{………………} \quad (86)$$

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

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

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

$$M_b \frac{\mu_o}{\gamma_o} \frac{Z^1}{Z} = \alpha \quad \text{………………} \quad (89)$$

$$\frac{C_A}{K_{Ao} + C_A} \frac{Z^1}{Z} = \alpha \quad \text{………………} \quad (90)$$

$$Z = A \frac{\alpha}{M_b \frac{\mu_o}{\gamma_o}} Z \quad \text{………………} \quad (91)$$

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

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

$$Cs_6 = A\ell^{\frac{\alpha}{M_b \frac{\mu_o}{\gamma_o}}} B\ell^{\frac{\alpha}{M_b \frac{\mu_o}{\gamma_o}}} \quad \text{………………} \quad (93)$$

$$Cs_6 = AB\ell^{(x-x)} \frac{\alpha}{M_b \frac{\mu_o}{\gamma_o}} x \quad \text{………………} \quad (94)$$

Constant deposition of the contaminant from arsenic and nitrogen are influenced by several factors, the rate of deposition varies base these factors in the formation, but in some instances there are tendency of developing uniform stratification producing homogeneous flow, the transport concentrations are influenced by these stated condition as it is expressed above in the derived solutions.

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

$$Cs_6 = (o) = C_o \quad \text{………………} \quad (95)$$

So that equation (96) becomes

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

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

$$Cs_6 = 0 \quad \text{………………} \quad (97)$$

As the transport of the contaminant continue, the behaviour of the substance change in population and in concentration including degradation under the influences of death of the microbes, such condition are expressed in the derived solution stated in equation [97].

Therefore, solution of the system is of the form

$$Cs = Cs_1 + Cs_2 + Cs_3 + Cs_4 + Cs_5 + Cs_6 \quad \text{………………} \quad (98)$$

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

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

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

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

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

The expression here is the final developed model that will monitor deposition of arsenic and nitrogen influencing the migration of Edwardsiella. Homogenous gravel formation in coastal area of aboluma has been thoroughly assessed, the most influential parameters from formation characteristics is velocity of flow and dispersion rate in the strata. The study were able to consider several influences from other dimensions in developing the governing equation, the expressed equation were derived as all the considered parameters express their various roles in different phase, such application developed the final model equation stated in [100] above.

4. Conclusion

Velocity of flow and dispersion rate were found to developed a higher degree in the formation, such condition were consider to be influential to the migration process of Edwardsiella including arsenic and nitrogen depositions in the study area. The parameters in the system are deposited at different strata of the soil, but on transport process they are found to experience some physiochemical reaction in the strata, these results to fluctuation of the concentration including deposition in the formations, the study were confirmed through risk evaluations carried out in previous year, these investigation produces the results, but there was no defined solution that will prevent this spread of the contaminant in the study location. The application of mathematical methods were appropriate to establish frame work that will be applied to improve on the prevention for further migration of the contaminants, the derived solution from the governing equation produced the stated model in [100]. It will be applied to monitor and prevent these migration and deposition of these contaminants in the study location.

Reference

[1] Ajmal, M., A. A. Nomani, and A. Ahmad Ahmed, (2003). Heavy Metal resistance pattern of moderatelyhalophytic bacteria, journal of biotechnology 6, (2) 267-271.

[2] Ajmal, M., Nomani A. A., and Ahmad A. (1984). Acute toxicity of chrome electroplating wastes to icroorganisms - adsorption of chromate and chromium (VI) on a mixture of clay and sand. Water Air Soil Poll. 23:119-127.

[3] Anderson, R. A. (1989). Essentiality of chromium in humans. Sci. Tot. Environ. 86:75-81.

[4] Anyanmu, C. U. and Ugwu, C. E. (2010). Incidence of Arsenic Resistant Bacteria Isolated from sewage treatment plant. International Journal of Basic and Applied Science Vol. (10) No. 6: Pp1-2

[5] Arnold, R., T. Christina D, and M. R. Hoffman (1988). Reductive dissolution of Fe (III) oxides by Pseudomonas sp 200.journal of Biotechnol. Bioengineering. 32:1081-1096..

[6] Bianchi, V., and Levis A .V (1984). Mechanisms of chromium genotoxicity. Toxicological and Environmental Chemistry 9:1-25.

[7] Bianchi, V., Zantedeschi A, Montaldi A, and Majone F. (1984). Trivalent chromium is neither cyto –toxic nor mutagenic in permeabilized hamster fibroblasts. Toxicol Lett. 23:51-59.

[8] Bondarenko, B. M., and A. T. Ctarodoobova.(1981). Morphological and cultural changes in bacteria under the effect of chromium salts. J Microbiol. Epidemiol. Immunobiol. USSR. 4:99-100.

[9] Bopp, L. H.. Chakrabarty A.M, and Ehrlich H. (1983). Chromate resistance Plasmid in Pseudomonas [10] Bowen, H. J. M.(1979). Environmental chemistry of the elements. Academic Press, New York. PP 1 -2

[11] Coleman, R. N., and J. H. Paran .(1983). Accumulation of hexavalent chromium by selected bacteria. Environ. Technol. Lett.(4):149-156.

[12] Cupo, D. Y., and Wetterhahn K. E. (1984). Repair of chromate-induced DNA damage in chick-embryo hepatocytes. Carcinogenesis 5:1705-1708.

[13] Darrin, M. 1956. Chromium compounds-Their industrial use, In M. J. Udy (ed.), Chromium. Reinhold, New York. PP 251-262

[14] DeFlora, S., V. Bianchi, and A. G. Levis. (1984). Distinctive mechanisms for interaction of hexavalent and trivalent chromium with DNA Toxicol. Environ. Chem. 8:287-294.

[15] Deveral S. J., Gilliom R.J, Fujii R, Izbicki J. A, and Fields J.C (1984). A real contribution of selenium and other inorganic constituents in shallow ground water of the San Luis Drain Service Area, San Joaquin Valley, California: A preliminary study report.pp1

[16] Fablemne, G. (2003). Analysis of Microbial Community Structure and Functions in heavy metal contaminated soils using molecular methods (PhD) Dissertation.

[17] Gaines, R. W. (1988). West San Joaquin Valley Agricultural setting-A Report.

[18] Gkass, S. S (2009). The effect of heavy metal and temperature microbial growth and lag global West Journal Vol. II No.3 pp 325.

[19] Kamka,S. (2002). Microbial Cr(Vi) Reduction: Role of Electron Donor acceptor and mechanics with special emphasis on clostridium spp.

[20] Okpokwasili, G. C. and Nweke, C. O. (2005). Microbial Growth and substrate utilization kinetics, African Journal of Biotechnology Vol. (4) pp. 305.

[21] Rathnayak, M. V. N. Rathnayake, M Megharaj, N Bolan R .N (2010). Tolerance of heavy metals by positive soil bacteria, International Journal of Civil and Environment.

[22] Rabia, A. Tasneam A. (2007). Effect of Heavy metal on soil microbial Community and ming Beans seedgermination journal of botany 39(2): 629-636, .

[23] Wyzkowska, J. (2002). Soil contamination by chromium and enzymatic activity and yield.journal of environmental studies 4: 79-84

[24] Šmejkalová M, Mikanová o,Borůvka l l (2003). Effect of heavy metal concentration on Biological activity of soil micro-organism. Journal of plant and soil Environment 49 p 321
.
[25] Eluozo, S. N. Ademiluyi, J. O. and Ukpaka, C. P Development of mathematical model to predict the effect of chromium on E.coli growth rate on groundwater at Omoku town in Niger delta area of Nigeria International Journal of Applied Chemical Sciences Research Vol. 1, No. 5, June 2013, PP: 24 - 43