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Research article

CARBON AND SALMONELLAE MODEL TRANSPORT ON VERTICAL AND HORIZONTAL DEPOSITED GRAVEL FORMATION IN COASTAL AREA OF BORIKIRI OF PORT HARCOURT METROPOLIS, NIGER DELTA OF NIGERIA

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Abstract

Pollution sources from carbon and salmonellae are deposited at Vertical and horizontal column, these solutes were found to develop a serious hazard in coastal area of Borikiri location of Port Harcourt metropolis. The depositions of carbon and salmonellae are predominantly through manmade activities in the study location. Risk assessments carried out in the study location discovered several pollution sources emanating from salmonellae and carbon. Such pollution sources are through high settlement of manmade activities that generate various levels of salmonellae and carbon depositions in the study area. It predominantly deposit in some part of the area under study, such deposited high concentration of the substances need serious conceptual system to prevent salmonellae and carbon in soil and water environment. This condition has developed lots of challenges generating serious pollution in costal formation, base on this factors mathematical model where find appropriate to generate a model that will monitor the deposition of carbon and salmonellae in the study location, the expressed model were derived base on several established conditions that influences the transport of salmonellae and carbon in horizontal and vertical column. The model will be useful to experts on the field to ensure that they monitor the migration rate of carbon and salmonellae concentration and prevent it from further transport, this depositions increase the level of substrate utilization for salmonellae growth in vertical and horizontal directions, it also implies that there is the tendency of high population of salmonellae under the influences of dispersions in the strata.

Keyword: carbon and salmonellae transport, vertical and horizontal and gravel formation

1. Introduction

Anthrax is known to be acute bacterial infection of primarily herbivores, which is infectious to humans. The etiologic agent, *Bacillus anthracis*, is a gram-positive spore developing rod shaped microbes. Animals become contaminated by ingesting spores or perhaps by being bitten by flies that have fed on an infected animal or carcass (Ebedes, 1976). Contaminated animals are normally found dead as death can happen within 24 hours. (Whitford and Hugh-Jones, 1994). Anthrax can be established universal affecting wildlife, livestock, and humans. During epidemics in 1959/60 and 1970 in the Kruger National Park, South Africa, anthrax deaths numbered in the thousands (De vas 1976). Livestock luggage's are identified to contribute to human cases through the cutaneous gastrointestinal and inhalation route. In 2000, the first gastrointestinal cases were reported in the United States after the family ate beef from an infected carcass (Dragon and Rennie 2001: Pamala, 2002).Although environmental contamination with *B. anthracis* spores occurs because of wildlife and domestic livestock cases, the degree or level of pollution from each case is unknown. Anthrax spores are known to persevere in the surroundings for years and are opposed to ecological factors (Turnbull 1996). Spores may be found in soil contaminated by diseased animals or in diseased animal products such as hair, wool, hides, and bones (Beyer, et al 1995, Lindedeque and Turnbull 1994). Very little research has been done on anthrax spore survival under natural conditions. Eight hundred and eighty four million people were estimated from WHO to lack access to enhanced water sources, and estimated 2.6 billion populace do not have access to enhanced sanitation (UNICEF and WHO 2010a UNICEF and WHO 2010b UNICEF and WHO 2010c). In 2000, it is confound that Water Supply and Sanitation joint Council (WSSCC), a universal multi-partner organization intended at enhancing entrance to safe water and hygiene, established three precise targets for water supply and sanitation: 1) decrease the amount of people lacking access to hygienic sanitation facilities by one half by 2015, 2) decrease the amount of people without access to a sustainable source of quality drinking water by one half by 2015 (where superiority water is defined as assembly the WHO guidelines for safe drinking water), and to provide water, sanitation and hygiene for all by 2025 where sanitation was defined as full coverage of hand washing, safe disposal of feces, as well as safe water handling and storage (UNICEF and WHO 2000). eight goals has been confound to have been set by united nations to achieve this Millennium Development Goals (MDGs) the aim is to increase equality and decrease poverty universal, and among these, was the goal is to decrease the number of people who do not have access to safe water and improved sanitation by half by 2015 (UN 2011). Ever since 2000, exponential coverage of 7 and 10% worldwide for superior sanitation and water access respectively has occurred. However, if radical improvements towards the MDGs are not prepared, then in 2015 an predictable 2.7 billion people were confirm have access to enhanced sanitation, more so 672 million will be lacking better drinking water sources, reaching the MDG for water access and missing the sanitation target by 13% (UN 2010; UNICEF and WHO 2010c). The load of lack of access to secure water sources and enhanced hygiene falls heavily on people in developing nations and is even a more ordinary trouble for people living in rural areas compared to those living in urban environments (UNICEF and WHO 2010c). Rural populations account for around 84% of the people lacking access to improved water sources and sanitation services (UNICEF and WHO 2000). The WHO defines enhanced drinking water sources as those with knowledge that is most likely to deliver safe water to persons, such as family relations to piped water, public standpipes, boreholes, protected wells, and rainwater catchments (WHO 2004). It is significant to note that insecure wells, springs, water sold from vendors and tanker trucks fall under the heading of "unimproved water sources." (WHO 2004).Pathogens are frequently multiply in low concentrations into water supplies making them hard and costly to detect. But some microorganisms can be used to indicate pathogen existence in water; however the association is not always a straight connection (Ashbolt et al. 2001; EPA 2009). Ashbolt et al. (2001) describe three types of microbial indicators: 1) process indicators, 2) fecal indicators, and 3) index organisms. Microbes are deposited in intestines of warm-blooded mammals and are discarding into the environment in excreta (Ashbolt et al. 2001; EPA 2010). Total coliform bacteria may occur in human intestines; these sources of contaminants are found in animal excreta, soil, and from other man made activities (EPA 2010). Total coliforms are considered process indicators and used for drinking water analysis confirmed to notice the presence of pollutants; however they do not precisely compare to pathogen pollution. The existence of total coliforms in treated drinking water indicates incomplete treatment, treatment failure, or post-treatment contamination. Fecal coliforms and *E. coli* are more closely linked to fecal contamination from warm-blooded mammals than total coliforms, although both can be found in the environment from non-fecal sources (Ashbolt et al. 2001; EPA 2010). Fecal coliforms and *E. coli* are less useful as environmental indicators of water quality due to the possibility of nonfecal origins, but they are generally good indicators of fecal contamination in drinking water (EPA 2010). *E. coli* is not only recommended as an indicator of fecal contamination, but can also be used as an index organism along with Enterococci (a fecal streptococci bacteria), because their presence often occurs with *Vibrio cholerae*, *Salmonella*, *Cryptosporidium parvum*, and other water-borne bacteria shed into the environment along with excreta (EPA 2010; NRC 2004, Stephen 2008).

2. Theoretical background

Salmonellae and carbon transport in soil and water environment were found to be predominantly causing lots of ill health, it has been a subject of serious concern due to it health implication, this is due to its rate of toxicity in soil and water environment, salmonellae and carbon are mostly derived from manmade activities in the study area, such examination were carried out from risk assessment to monitor the rate of concentration at different formation from organic to aquiferous zone this pollution has been under the influences of disintegration of the porous rock developing different formation . The study area are predominant with coastal deposition influenced by high degree of void ratio and porosity, this implies that the condition of the formation Determine the rate of formation deposition, the structure of the formation are base on the geological formation, the study were area examined through risk assessment observed to deposit high degree of void ratio between unconfined formation, the substance were observed to develop high concentration, this implies that the formation that deposit above may generate more accumulation between the organic and lateritic soil, such observation implies that the stratification of the formation are influenced by formation characteristics influenced by geologic history of the study area. The deposition of salmonellae at vertical and horizontal direction of fluid flow in the strata are influenced by the structural disintegration of the porous rock, porosity and void ratio were the formation characteristics that are found to influences the directions of flow on the transport system. The study developed a system to monitor the transport of salmonellae and carbon in vertical and horizontal direction in the formation, the concept is to mathematically model the direction of transport in the study area, the expressed governing are stated bellow.

3. Governing equation

$$K\phi\frac{\partial C}{\partial t} = U\frac{\partial C}{\partial x} = D\frac{\partial^2 C}{\partial y^2} + f(x,y) \qquad \text{..............................} \qquad (1)$$

Permeability and Porosity are formation characteristics that determine the movement of fluid, the system were formulated to express the transport of salmonellae and carbon in two dimensional transport condition, this substance is of serious concern due to health implication involve , the stratifications plays major roles in the deposition of salmonellae and carbon in the study area, base on these factors mathematical model were found appropriate to mathematically model the direction of these transport from organic to unconfined formations, the defined governing equations are stated below.

$$K\phi\frac{\partial C}{\partial t} + U\frac{\partial C}{\partial x} = f(x,y) \qquad \text{..............................} \qquad (2)$$

Let $C = TX$

$$\frac{\partial C}{\partial t} = T^1 X \qquad \text{..............................} \qquad (3)$$

$$\frac{\partial C}{\partial x} = TX^1 \qquad \text{..............................} \qquad (4)$$

$$K\phi T^1 X + UTX^1 = f \qquad \text{..............................} \qquad (5)$$

$$K\phi\frac{T^1}{T} + U\frac{X^1}{X} = f \qquad \text{..............................} \qquad (6)$$

$$K\phi \frac{T^1}{T} = f \qquad \text{.............................} \qquad (7)$$

$$U \frac{X^1}{X} = f \qquad \text{.............................} \qquad (8)$$

From (7), $K\phi \frac{dT^1}{T} = fdt$ .... (9)

$$\int \frac{dT^1}{T} = \int \frac{f}{K\phi} dt \qquad \text{.............................} \qquad (10)$$

In $T = \frac{f}{K\phi} t + a_1$ .... (11)

$$T = \ell^{\frac{f}{K\phi} t + a_1} \qquad \text{.............................} \qquad (12)$$

$$T = C_1 \ell^{\frac{f}{K\phi} t} \qquad \text{.............................} \qquad (13)$$

$$U \frac{dX^1}{X} = fdx \qquad \text{.............................} \qquad (14)$$

$$\int \frac{dX}{X} = \int \frac{f}{u} dx \qquad \text{.............................} \qquad (15)$$

In $X = \frac{f}{u} x + a_2$ .... (16)

$$X = \ell^{\frac{f}{u} x + a_2} \qquad \text{.............................} \qquad (17)$$

$$X = C_2 \ell^{\frac{f}{u} x} \qquad \text{.............................} \qquad (18)$$

But $C = TX$

$$C_1 = C_1 \ell^{\frac{f}{K\phi} t} \bullet C_2 \ell^{\frac{f}{u} x} \qquad \text{.............................} \qquad (19)$$

$$C_1 = C_1 C_2 \ell^{\left(\frac{t}{K\phi} + \frac{x}{u}\right) f} \qquad \text{.............................} \qquad (20)$$

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$$C_1 = C\ell^{\left(\frac{t}{K\phi} + \frac{x}{u}\right)f} \qquad \text{.............................. (21)}$$

The expression at [21] shows that the transport of are in exponential phase, this migrating direct from the point sources of discharge to phreatic zone , the location deposit high degree of permeability and porosity, it also reflect on the porosity of the soil, but the study considered the deposition influenced by climatic conditions. whereby the deposition of the formation are in deltaic environment, it experiences high rain intensities pressuring the migration of the solute to where the percentage of permeability and porosity are very high.

$$\phi \frac{\partial C_2}{\partial t} = D \frac{\partial^2 C_2}{\partial y^2} \qquad \text{.............................. (22)}$$

Let $C = TY$

$$\frac{\partial C}{\partial t} = T^1 Y \qquad \text{.............................. (23)}$$

$$\frac{\partial^2 C}{\partial y^2} = TY^{11} \qquad \text{.............................. (24)}$$

$$K\phi T^1 Y = DTY^{11} = \lambda^2 \qquad \text{.............................. (25)}$$

Let

$$K\phi \frac{T^1}{T} = D \frac{Y^{11}}{Y} = -\lambda^2 \qquad \text{...................... (26)}$$

$$\int \frac{dT}{T} = \int \frac{-\lambda^2}{K\phi} dt \qquad \text{.............................. (27)}$$

$$\text{In } T = \frac{-\lambda^2}{K\phi} t + a_3 \qquad \text{.............................. (28)}$$

$$T = \ell^{\frac{-\lambda^2}{K\phi} + a_3} \qquad \text{.............................. (29)}$$

$$T = C_3 \ell^{\frac{-\lambda^2}{K\phi} t} \qquad \text{.............................. (30)}$$

$$D \frac{Y^{11}}{Y} = -\lambda^2 \qquad \text{.............................. (31)}$$

$$\frac{d^2y}{dy^2} + \frac{\lambda^2}{D}Y = 0 \qquad \text{..............................} \qquad (32)$$

Auxiliary equation is

$$m^2 + \frac{\lambda^2}{D}Y = 0 \qquad \text{..............................} \qquad (33)$$

$$m \pm i \frac{\lambda}{\sqrt{D}} \qquad \text{..............................} \qquad (34)$$

$$Y = A\,Cos\frac{\lambda}{\sqrt{D}}y + B\,Sin\frac{\lambda}{\sqrt{D}}y \qquad \text{..............................} \qquad (35)$$

Combine (6) and (7), we have;

$$C_2 = TY$$

$$V_2 = C_3\ell^{\frac{-\lambda^2}{K\phi}t}\left(ACos\frac{\lambda}{\sqrt{D}}y + ASin\frac{\lambda}{\sqrt{D}}y\right) \qquad \text{........................} \qquad (36)$$

Considering

$$U\frac{\partial v_3}{\partial x} = D\frac{\partial^2 v_3}{\partial y^2} \qquad \text{..............................} \qquad (37)$$

Let $C_3 = XY$

$$\frac{\partial v_3}{\partial x} = X^1Y \qquad \text{..............................} \qquad (38)$$

$$\frac{\partial^2 C_3}{\partial y^2} = XY^{11} \qquad \text{..............................} \qquad (39)$$

$$UX^1Y = DXY^{11} \qquad \text{..............................} \qquad (40)$$

$$U\frac{X^1}{X} = D\frac{Y^{11}}{Y} = \rho^2 \qquad \text{..............................} \qquad (41)$$

$$U\frac{X^1}{X} = \rho^2 \qquad \text{..............................} \qquad (42)$$

$$\frac{X^1}{X} = \frac{\rho^2}{U} \qquad \text{.............................} \qquad (43)$$

$$\text{In } X = \frac{\rho^2}{U}x + a_4 \qquad \text{.............................} \qquad (44)$$

$$\text{i.e. } X = \ell^{\frac{\rho^2}{U}x + a_4} \qquad \text{.............................} \qquad (45)$$

$$X = C_4 \ell^{\frac{\rho^2}{U}x} \qquad \text{.............................} \qquad (46)$$

$$D\frac{Y^{11}}{Y} = \rho^2 \qquad \text{.............................} \qquad (47)$$

$$\frac{d^2y}{dy} - \frac{\rho^2}{D}Y = 0 \qquad \text{.............................} \qquad (48)$$

Auxiliary equation is

$$m^2 - \frac{\rho^2}{D} = 0 \qquad \text{.............................} \qquad (49)$$

$$m = \pm \frac{\rho}{\sqrt{D}} \qquad \text{.............................} \qquad (50)$$

$$Y = D\ell^{\frac{\rho}{\sqrt{D}}y} + E\ell^{\frac{-\rho}{\sqrt{D}}y} \qquad \text{.............................} \qquad (51)$$

Combining (46) and (51), yield;

$$V_3 = XY$$

i.e.

$$\boxed{C_3 = C_4 \ell^{\frac{\rho^2}{U}x}\left(D\ell^{\frac{\rho}{\sqrt{D}}y} + E\ell^{\frac{-\rho}{\sqrt{D}}y}\right)} \qquad \text{..............} \qquad (52)$$

Combining (5), (8) and (11), yield;

$$V(x, y) = C_1 + C_2 + C_3$$

$$C(x,y) = C\ell^{\left(\frac{t}{K\phi}+\frac{x}{u}\right)f} + C_3\ell^{\frac{-\lambda^2}{K\phi}t}\left(ACos\frac{\lambda}{\sqrt{D}}y + ASin\frac{\lambda}{\sqrt{D}}y\right)$$

$$C_3 = C_4\ell^{\frac{\rho^2}{U}x}\left(D\ell^{\frac{\rho}{\sqrt{D}}y} + E\ell^{\frac{-\rho}{\sqrt{D}}y}\right) \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (53)$$

The expression in [53] is the developed model for vertical and horizontal direction of flow in coastal area, the study was carried out in coastal area of Borikiri of port Harcourt metropolis, the deposition of the substances are from manmade activities at optimum level, the formation are between the deltaic environment whereby lots of formation influences are observed in the study area. Vertical and horizontal direction of flow were carried out to ensure the direction of carbon and salmonellae transport are monitored in the study area, this will ensure the rate of dispersions and it concentration comparing the two direction of flow in the strata.

4. Conclusion

Carbon and salmonellae depositing in Vertical and horizontal direction of flow has been found to be predominant in the coastal area of Borikiri, the study focus it object in monitoring the transport of carbon and salmonellae in the study location, health implication of carbon and salmonellae deposition in coastal formation was express on the developed system that generated the governing equation for the study. Such examination is defined to predominantly depopsitcarbon and salmonellae location of port Harcourt metropolis, such developed has generated lost heavy metal deposition in various variations, the deposition of carbon and salmonellae has lots of health implication in coastal location , therefore it implies that the migration will definitely higher concentration in aquiferous zone. Therefore the development mathematical model should generate better solution to monitor the rate of concentration in two direction of transport, it is imperative for the study area to determine the rate of concentration at different formation to phreatic deposition, the prevention of the substances from further migration and dispersion should be the paramount objective , because the deposition of this substance is a serious challenge to environmental health, the development of mathematical model were fine suitable to ensure that the rate of transport and are determined, this will develop a base line to prevent the transport to shallow deposited aquifer in the study area.

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