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Research article

MATHEMATICAL MODEL TO MONITOR THE INFLUENCE OF FLOW NET ON VIRUS TRANSPORT IN HOMOGENEOUS SAND GRAVEL IN COASTAL AREA OF WARRI.

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Abstract

The influences of flow net on virus transport has thoroughly expressed, the behaviour of the contaminant were evaluated through intensive investigation on hydrological condition in the coastal area of Warri, formation characteristics such as permeability coefficient were predominantly deposited in the study area. A flow net can be used to determine the distribution of hydraulic head, the ground-water velocity distribution, ground-water and solute flow paths and flow rates, including the general flow pattern in a ground-water system, the impact of flow net has definitely express various way it pressure the virus transport through the direction of flow path, this study were able to monitor the migration process through the flow net path in homogeneous gravel formation, the derived model from the developed governing equation generated model at various phase of transport condition influenced by the direction of flow net, experts will definitely apply the concept to monitor virus transport in homogeneous gravel formation.

Keywords: Mathematical model, flow net, virus transport and homogeneous gravel

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1. Introduction

Over the last few decades deterioration of both the quality and quantity of groundwater has become a global phenomenon, which will further intensify the demand for drinking Water increases [1]. Numerous severe cases of groundwater contamination with reference to storm water infiltration have been documented worldwide [6, 2 and 16]. Few studies have also been documented nationally on groundwater with reference to major ions, trace elements and bacteriology [11, 16, and 17]. However literature is silent on the impact of storm water infiltration into groundwater. In recent years attention on the increasing ionic concentration of traces metals in groundwater as result of storm water infiltration has been studied by various workers [1, 4, 5, 6, 12, and 15]. These have been attributed to human interference, proliferation of industries and recent agriculture practices in urban areas where storm water flow recharges the aquifer system and thus degrading the water quality. It is often difficult to determine the exact source of major ions pollutants [3], because there are many potential sources of groundwater contamination including urban storm water runoff. Storm water infiltration in urban areas is cause of concern with regard to the risk of groundwater pollution [7, 8, and 16. Storm water infiltration has been shown to affect groundwater quality and quantity (Pitt, 1996; [3, 12]. Contaminants present in urban storm water include volatile organic compound, pesticides, nutrients, and trace elements [2, 4]. This can originate at the land surface or in the atmosphere [6]. Some constituents either volatize during storage or sorbs to the particulate matter [6] and are not transported to the water table; however, are more persistent, and may threaten groundwater quality. [6] Studding the impacts from sub surface infiltration at three sites in Sweden and concluded that storm water infiltration affects the groundwater quality to a small extent. In a vast majority of developing countries, fast growing populations combined with poor living conditions in rural areas have forced many people to migrate to cities in search of better living conditions. This has led to a dramatic expansion of most of the major cities throughout developing countries, mainly via the uncontrolled growth of slums or squatter settlements on their fringes [9, 10 and 13]. Nitrogen is one of the most abundant elements in the Earth’s biosphere and one of the six elements (C, H, O, N, P, and S) that are the major constituents of living tissue. Nitrogen gas (N2) comprises approximately 78% of the Earth’s atmosphere, but this is largely unavailable as a nitrogen source for most living organisms. Consequently, nitrogen availability in all ecosystems is largely dependent on inputs of biologically available nitrogen from external sources or internal cycling of nitrogenous compounds into biologically available forms. Nitrogen often limits biological production in estuaries, oceans, and many terrestrial systems [26], and can be limiting in lakes [5, 15] streams [4, 21], and wetlands [26]. However, excess nitrogen can have detrimental effects. For example, excess nitrogen or nitrogen saturation (nitrogen losses approaching nitrogen inputs) can lead to increased losses of nutrient cations and increased soil and water acidity in forest ecosystems [23]. In aquatic habitats, excess nitrogen can lead to eutrophication or levels of ammonia (NH3), nitrite (NO2 -), and nitrate (NO3 -) toxic to humans, livestock, and wildlife [18, 19, 20, 26, 27,]. Land application of waste from confined animal production facilities is an effective method of disposing of animal waste while supplying nutrients to crops and pastureland. However, it has been well-documented that runoff from agricultural livestock and poultry litter applied areas is a source of faecal contamination in water [18, 21, 24, 25]. The EPA’s National Water Quality Inventory report [11, 12, 14, and 15] identified bacteria as the leading cause of impairments in rivers and streams in the United States and agricultural practices were identified as the leading source of all bacterial impairments.

2. Theoretical background

The behaviour of virus on soil has been a serious concern, these are through ground water deposition through flow net in various stratification. The transport of virus on direction of ground flow were confirm to influences the migration of virus to ground water aquifers, these condition has lots of other pressures in the transport process. Subject to these challenges, the consequences have definitely cause alarming increase of various diseases in the study area., the deposition of virus are also pressured by other formation variables, these condition structural stratification varies base on geomorphology geochemistry influences in deltaic formation, these predominance's chemical deposition that should have inhibited but were found in the study location not influences the deposition of virus rather it concentration continue to increase in the study area, the rate porous media in the deposited formation has express lots of variations thus pressure the directions of low net in the strata, the predominant deposited gravel formations deposited homogeneous setting, it also pressure the migration process of the virus to ground water aquifers, such influences in the system were considered in developing the system to generated the governing equation. The expressed model will be derived in phase base on the behaviour of the virus thus the formation characteristics influences in the study location. These derived solutions will develop model according to the conditions considered in the transport process in the strata.

3. Developed governing equation

$$Vq\frac{\partial c}{\partial t} - K\frac{\partial c}{\partial z} - \frac{n_f}{N_d}\frac{\partial c}{\partial z} = \beta \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

The expressions are the developed governing the be derived to generate model at different phase, the governing equation, the study applying this expression in [1] are developed base on the considered variables that will definitely pressure the migration of virus to ground water aquifers the influences of flow net were considered in the study to monitor the rate of pressure from these variable, most predominant deposition are the degree of permeability in the structural stratification of the formation, the derived solution will definitely develop different phase base on the deposition and other factors that will pressure the system.

$$Vq\frac{\partial c}{\partial t} = K\frac{\partial c}{\partial z} + \frac{n_f}{N_d}\frac{\partial c}{\partial z} + \beta \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

$$Vq\frac{\partial c}{\partial t} = \left(K + \frac{n_f}{N_d}\right)\frac{\partial c}{\partial z} + \beta \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

$$Vq\frac{\partial c}{\partial t} = \beta \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (4)$$

$$\frac{\partial c}{\partial t} = \beta Vq \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (5)$$

$$c_1 = \beta Vq + \tau \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (6)$$

$$Vq\frac{\partial c_2}{\partial t} = \left(K + \frac{n_f}{N_d}\right)\frac{\partial c}{\partial z} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \tag{7}$$

Let $c_2 = ZT$ $\qquad \ldots\ldots\ldots\ldots\ldots\ldots$ (8)

$$\frac{\partial c_2}{\partial t} = ZT^1 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \tag{9}$$

$$\frac{\partial c_2}{\partial z} = Z^1T \qquad \ldots\ldots\ldots\ldots\ldots\ldots \tag{10}$$

Substitute (9), (10) into (7) we have;

$$VqZT^1 = \left(K + \frac{n_f}{N_d}\right)Z^1T \qquad \ldots\ldots\ldots\ldots\ldots\ldots \tag{11}$$

$$Vq\frac{T^1}{T} = \left(K + \frac{n_f}{N_d}\right)\frac{Z^1}{Z} = \tau \qquad \ldots\ldots\ldots\ldots\ldots\ldots \tag{12}$$

$$Vq\frac{T^1}{T} = \tau \qquad \ldots\ldots\ldots\ldots\ldots\ldots \tag{13}$$

$$\left(K + \frac{n_f}{N_d}\right)\frac{Z^1}{Z} = \tau \qquad \ldots\ldots\ldots\ldots\ldots\ldots \tag{14}$$

From $\beta \frac{T^1}{T} = \frac{\tau}{Vq}$ $\qquad \ldots\ldots\ldots\ldots\ldots\ldots$ (15)

$$Ln\, T = \frac{\tau}{Vq}t + c_3 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \tag{16}$$

$$T = A\ell^{\frac{\tau}{Vq}t} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \tag{17}$$

The expression at this phase of the derived solution generated in this model is to monitor the rate of migration with respect to time, this developed model express in the system monitor the deposition of virus through the flow net with respect to the rate velocity from the fluid flow in the lithology of the formation, the behaviour were monitor in an exponential condition predominantly with the deposition of permeability coefficient in the lithology of the formation. From (12) $\left(K + \frac{n_f}{N_d}\right)\frac{Z^1}{Z} = \tau$

$$\frac{Z^1}{Z} = \frac{\tau}{K + \frac{n_f}{N_d}} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (18)$$

$$Ln\,Z = \frac{\tau}{K + \frac{n_f}{N_d}} z + c_4 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (19)$$

i.e. $Z = B\ell^{\frac{\tau}{K + \frac{n_f}{N_d}} z}$ .... (20)

Put (17) and (20) into (8) we have

$$c_2 = A\ell^{\frac{\tau}{Vq}t} * \beta\ell^{\frac{\tau}{K + \frac{n_f}{N_d}} z} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (21)$$

$$c_2 = AB\ell^{\left(\frac{\tau}{Vq} + \frac{z}{K + \frac{n_f}{N_d}}\right)\tau} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (22)$$

Hence general solution becomes $C(z,t) = \beta Vqt + \tau + AB\ell^{\left(\frac{\tau}{Vq} + \frac{z}{K + \frac{n_f}{N_d}}\right)\tau}$ (23)

The deposition of virus in soil and water environment has not been predicted from the pressure of flow net, the expressed model evaluate the direction of flow net on the impact it has on virus transport to ground water aquifers, such expression has establish the deposition of flow path in the formation to be the major impact on migration of virus through permeability coefficient in the study location, the deposition of permeability in the study area were found in the system to predominantly deposit in the formation, such condition were considered in the developed governing equation as expressed above. Furthermore, determining the direction of ground-water flow and the degree of hydraulic gradients is significant because these parameters influence the direction and rate of contaminant migration. Ground-water flow directions are represented by a three-dimensional set of equipotential lines and orthogonal flow lines. If a plan view (potentiometric surface, or water table elevation, map) or a two-dimensional cross-section is drawn to represent a flow system, the resultant equipotential lines and flow lines constitute a flow net. A flow net can be used to determine the distribution of hydraulic head, the ground-water velocity distribution, ground-water and solute flow paths and flow rates, and the general flow pattern in a ground-water system.

4. Conclusion

The pressured from flow net in the migration of virus has been expressed, the study monitor the migration of the contaminant on the flow path between the intercedes of the formation, such deposition were found to be predominant in the in the deposited formation, the behaviour of virus transport should be influenced through this direction of flow net thus pressure the deposition of the contaminant in the study location. Ground-water flow is strongly influenced by the locations of ground-water divides and by recharge from and discharge to surface water bodies such as rivers, streams, lakes, and wetlands. Topographic highs generally represent divergent flow boundaries (divergent ground-water divide), and topographic lows such as valleys or drainage basins typically represent convergent flow boundaries (convergent ground-water divide). In addition, the configuration of the water table is typically a subtle reflection of the surface topography in the area. However, topography is not always indicative of subsurface flow patterns and should not be depended upon unless confirmed by head data. In order to place the local hydrogeologic flow system within the context of the regional hydrogeologic flow system, it is important to have an understanding of the local and regional topography. Included in this must be knowledge of the locations of natural and manmade surface water bodies. This information can generally be gained from topographic maps published by the United States Geological Survey. These conditions were methods applied to determine the hydrological deposition in coastal area of Warri, such process thoroughly express ground water condition in such deltaic formations.

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