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Research article

ONE DIMENSIONAL FLOW TRANSPORT TO MONITOR METHYLOCOCCUS DEPOSITION PRESSURED BY TWO DIMENSIONAL DISPERSIONS IN CHOKOCHO RIVER, RIVERS STATE OF NIGERIA

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Abstract

One dimensional flow transport to monitor Methylococcus in chokocho River were observed through mathematical modeling approach, the study examined the transport system of this microbes through non point sources in these localities, investigation were carried out, to monitor the rate of concentration considering various conditions expressed in the system, these derived solution produces a model for the study, the research has express various condition and approach other variables in the system pressured the deposition of Methylococcus in the River, the derived solution has definitely produced various concept that express the rate of vertical and longitudinal dispersions, the velocity of flow were also examined in the system, these parameters has produces various influences on the condition of the Methylococcus concentration in chokocho River.

Keywords: one dimensional flow, Methylococcus, two dimensional dispersions and Chokocho River

1. Introduction

Anthropogenic impacts have led to major changes and water management problems during the last decades. Critical water management problems are floods, which frequently extend into the Rhine River during spring time, and loss of habitat for aquatic organisms. Especially changes of the riverbed morphology, implemented to facilitate navigation, have caused deterioration of river habitats. Main problems for drinking water quality can be attributed to nitrate and phosphate leaching from agriculture as well as to emissions of heavy metals, biocides and substances affecting the endocrine system. The major solid waste disposal sites of the cities are located within the city limits, thus polluting the urban environment. These waste disposal sites are open systems, with no impermeable layer and with continuous low temperature burning. As a result of the above, the surface waters and the aquifers near urban areas area highly polluted, Ganoulis et al 2005. In the European Community, the recently introduced Water Framework Directive (CEC2000 Neil, 2004) requires that member states formulate River Basin Management Plans which identify objectives for achieving good water quality status on a catchment-wide basis. Similar standards apply to much of the world, for example catchment management in the United States has been guided by the Environmental Protection Agency's Water Quality Criteria and Standards Plan (US EPA 1998), in Australia by the National Water Quality Management Strategy (DAFF 2000) and in China by the Environmental Quality Standard for Surface Water (PRC SEPA 1999). Simulation models are a central part of these basin management plans because they can apply best available scientific knowledge, conditioned by historical evidence, to predict water quality responses to changing controls. For example, the development of the integrated catchment model BASINS is an explicit part of basin management plans in the United States (US EPA 1998, 1999), and the UK government has recently commissioned new tools for diffuse source modelling (DEFRA 2002: Neil, 2004). The new high expectations for the aquatic environment, incorporated into the current wave of directives and regulations, is prompting additional complexity with regard to modelling spatial variability, micro-pollutants and ecological indicators (Somlyody et al. 1998, Thomann 1998). Facilitated by improved computational resources, there is a trend for spatial discretizations to be increased, multi-media and multi-constituent models to be developed (e.g. Havnø et al. 1995, Cole and Wells 2000, Neitsch et al. 2002), and for traditional water quality determinants to be broken down into constituent species (Chapra 1999, Shanahan et al. 2001). As a consequence, the typical number of modelled components has risen exponentially over the past years, and this growth is expected to continue (Thomann 1998). Despite the increasing expectations placed upon water quality models, contemporary deterministic models, when audited, frequently fail to predict the most local and basic biological indicators with a reasonable degree of precision (e.g. Jorgensen et al. 1986). Even when models are claimed to be 'reliable' following audits, a very significant margin of error is allowed (e.g. Haitian et al. 1983). The application of modelling to the new era of high ecological standards presents severe challenges, especially given that our modelling experience is with relatively stressed ecological systems (Beck 1997, Shanahan et al. 1998), and that the economic implications of model errors may be relatively serious (Chapra 1997). While additional model complexity might be expected to improve the precision of model results, this has proven to be unfounded in a variety of studies (e.g. Gardner et al. 1980, Van der Perk 1997, and Lees et al. 2000, also see Young et al. 1996). Furthermore, future driving forces such as climate (Hulme et al. 2002) and distributed pollution sources (Shepherd et al. 1999) are poorly defined and they cannot be modelled with much precision.

2. Theoretical background

The behaviour of pollution has been observed in various dimensions by different researchers round the globe, the study of Methylococcus in rivers has not much been critically evaluated, there are lot of various microbes that has been investigated in rivers, but much has not been done on these type of microbial specie physiochemical parameters express the behaviour of this microbes, but there are other process in the deposition of the it in rivers that has not been evaluate, base on these facts it is imperative that the behaviour and the migration process of this microbes should be monitored, these conceptual frame work on these transport system of the microbes in the Rivers should has developed lots of conditions that are observed in the study location. Methylococcus capsulatus as microbes is describes is an obligately methanotrophic gram-negative, non-motile coccoid bacterium. This type of microbial specie M. capsulatus cells are encapsulated and tend to have a diplococcoid arrangement. It known to produces to methane, M. capsulatus that is able to oxidize some organic hydrogen containing compounds such as methanol. Similar condition are observed in M. capsulatus that has also been demonstrated to be thermotolerant- that is, The type of microbes are observed to grow well up to 50°C, with its optimum growth temperature of 37°C. Furthermore, M. capsulatus can live in conditions in which there is little molecular oxygen available. Methylococcus capsulatus is a Type I methanotroph, this implies that it is a constituent of the Gammaproteobacteria and that it utilizes such as ribulose monophosphate pathway (RuMP) for formaldehyde assimilation. Methane is first oxidized to methanol, which then gets converted into formaldehyde. Formaldehyde can then be 1) further oxidized to formate and carbon dioxide for energy production or 2) assimilated into biomass. (Ward et al 2004).

3. Governing Equation

$$Dy\frac{\partial c}{\partial t} = (Dx - Vo)\frac{\partial^2 c}{\partial z^2} + \frac{\partial c}{\partial z}$$

Nomenclature

C = Concentration [ML^{-3}]

D_y = Vertical Dispersion [LT^{-1}]

D_x = longitudinal Dispersion [LT^{-1}]

V_O = Velocity [L^{T-1}]

T = Time [T]

Z = Distance [L]

The expression here from the developed system produced the governing equation for the study, these expressions were critically developed base on parameters that were found imperative for the study, developed system were developed from the parameters that played serious role on the transport system of Methylococcus in Chokocho River. The rates of Methylococcus deposition are base the activities of the settlers in these localities. These provided lots of environmental assessments on various conditions, these microbes were found to predominantly deposit Chokocho River; the developed governing equation will definitely express various ways that the microbes can be monitored in Chokocho River.

Let C = TZ

$$Dy\frac{\partial c}{\partial t} = \varphi^2 \quad \text{..............................} \quad (1)$$

$$(Dx - Vo)Z^{11} + Z^{11} - \varphi^2 = 0 \quad \text{..............................} \quad (2)$$

From (1)

$$T = a\ell^{Dy\varphi^2 t} \quad \text{..............................} \quad (3)$$

The expression here show that the system are reacting on the initial concentration with respect to time under the influences on non point sources discharge of biological waste inside the River, the expression produced exponential phase of the system, these are were dispersion from initial concentration of the pollutant are considered in these direction of flow. The vertical dispersion were expressed base its role on the system, the rate of dispersion were pressured by the rate of velocity that may also be influences from other factors

$$DxM^2 - VoM - \varphi^2 = 0 \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (4)$$

$$M = \frac{Vo \pm \sqrt{Vo^2 + 4Dx\varphi^2}}{2Dx}$$

Hence, we have

$$X = ACosMz + BSinMz \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (5)$$

$$C(z,t) = a\ell^{Dy\varphi^2 t}\left[ACosMz + BSinMz\right] \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (6)$$

Subject equation (6) to the boundary condition

At $t = 0 \;\; z = 0 \;\; and \;\; C = 0$ yield:

$$0 = \alpha A$$

The rate of deposition were observed to migrate from non point source, therefore there should be condition that must considered be in the system, boundary values determined it limits of migration and deposition in the River, such condition were considered in the derived solution, these will enable the rate of migration and concentration monitored thus there level of influences through time and distances been evaluated in the transport system of the microbes. The behaviour of the microbes were also considered base on the rate of concentration at any point.

i.e. $C(z,t) = Co\ell^{Dy\varphi^2 t}\left[ACosMz + BSinMz\right] \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (7)$

$$\frac{\partial c}{\partial z} = Co\ell^{Dy\varphi^2 t}\left[-AmSinMz + BmSinMz\right]$$

At $Z = \frac{\partial c}{\partial z} = 0$

$$0 = Co\ell^{Dy\varphi^2 t}\, Bm \neq$$

We have

$$C(z,t) = Co\ell^{Dy\varphi^2 t}\left(CosMz\right) \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (8)$$

At $Z = L \;\; \frac{\partial c}{\partial z} = 0$, yield:

$$0 = Co\ell^{Dy\varphi^2 t}\left[-AmSinML\right]$$

$$Co\ell^{Dy\varphi^2 t} \neq 0$$

$$AmSinML = 0, n\pi, n, 2, 3$$

$$ML - n\pi \text{ i.e. } m = \frac{n\pi}{L}$$

Summing over Fourier series in the region of [o, L], we have

$$C(z,t) = Co\ell^{Dy\varphi^2 t}\left[\frac{ao}{2} + \sum_{n=1}^{\infty} an\ Cos\frac{m\pi}{L}\right] \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (9)$$

Where $bo = \frac{ao}{2}$ and $bn = an$

And $bo = \frac{1}{L}\int_{o}^{L} f(u)\, Cos\, udu$

So that, the pollutant will be flowing in the direction of *Z* at any given *t* as thus

i.e. $$C(z,t) = Co\ell^{Dy\varphi^2 t}\left[\frac{ao}{2} + \sum_{n=1}^{\infty} an\ Cos\frac{m\pi}{L}Z\right] \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (10)$$

The expressed derived solution applying furrier series were to critically evaluate the rate of migration in river and other developed environmental factors in the study area, lots of pollution has been observed years past, non point sources of pollution has been the most challenges facing the study area, therefore it is imperative that monitoring and evaluation of the rate of Methylococcus concentration are thoroughly done through these application, the derived solution will express the behaviour of Methylococcus deposition including its transport process from these applications.

Conclusion

The study has definitely express the concept of Methylococcus transport system in chokocho River, the deposition of this Methylococcus were observed to predominantly deposit in the River through investigation carried out, the transport of Methylococcus through non point sources in the localities were monitored through various conditions, the derived solution express various phase at various ways base on the behaviour of the microbes, the rate of initial concentration were considered, the rate of spread in vertical and longitudinal direction were monitored on the transport system, various parameter were expressed that determined there rates of influences on the migration level of Methylococcus in chokocho River, the rate of velocity pressured were also expressed in the system. The study is imperative because It will definitely monitor the rate of concentration through non point sources migration inside Chokocho River in the study area.

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