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MODELLING THE TRANSPORT OF STREPTOCOCCI ON HETROGENIOUS CAORSE SAND INFLUENCED BY POROSITY AND PERMEABILITY IN CAOSTAL AREA OF DEGEMA

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ABSTRACT

Modeling the migration of streptococci in deltaic environment has been thorough developed, the model is based on the rate of contaminant sources from streptococci in the study area, the ugly siege has caused a lots of water related diseases in study area, the rate of concentration is found to be very high, and the formation characteristics are also found to influence the microbial species to deposit high concentration in shallow aquifers. Water contamination in degema Niger delta of Nigeria is a serious threat to human settlement. Drinking water from natural sources such as rivers and streams are usually contaminated by macrobiotic substances from upstream users who use water for agricultural activities. The most common form of stream contamination connected with forestry activities is increased concentrations of soil particles washed into the stream by land disturbance, this include predominant saline deposition. The large particles sink to the bottom and increase the bed loads while, depending on the stream velocity, smaller particles remain in suspension. In several rivers, for example, studies have shown that the suspended matter can obstruct the penetration of light and limit the photosynthetic zone to less than 1 m depth. Suspended sediments in watercourses have become a serious concern for the water supply authorities this condition resulted to increased water treatment. The developed model will definitely reduce the transport of this type of microbial species in the study area.

Keywords: streptococci transport, heterogeneous porosity, permeability.

1. INTRODUCTION

Water is an elixir of life. It governs the evolution and function of the universe on the earth hence water is 'mother of all living world'. Majority of water available on the earth is saline in nature; only small quantity is fresh water. Fresh water has become a scare commodity due to over exploitation and pollution (Ghose and Basu, 1968; Gupta and Shukle, 2006; Patil and Tijare, 2001; Singh and Mathur, 2005). Pollution is caused when a change in the physical, chemical or biological condition in the environment harmfully affect quality of human life including other animals' life and plant (Lowel and Thompson, 1992; Okoye *et al*., 2002). Industrial, sewage, municipal wastes are been continuously added to water bodies hence affect the physiochemical quality of water making them unfit for use of livestock and other organisms (Dwivedi and Pandey, 2002). Uncontrolled domestic waste water discharge into pond resulted in eutrophication of ponds as evidence by substantial algal bloom, dissolve oxygen depletion in the subsurface water leads to large fish kill and other oxygen requiring organism (Pandey, 2003) Effluent is discharge into environment with enhanced concentration of nutrient, sediment and toxic substances may have a serious negative impact on the quality and life forms of the receiving water body when discharge untreated or partially treated (Forenshell, 2001; Miller and Siemens, 2003; Schulz and Howe, 2003). Water pollution by effluent has become a question of considerable public and scientific concern in the light of evidence of their extreme toxicity to human health and to biological ecosystems (Katsuro *et al*., 2004). The occurrence of heavy metals in industrial and municipal sewage effluents constitute a major source of the heavy metals entering aquatic media. Hence there should be regular assessment of these sewage effluents to ensure that adequate measures are taken to reduce pollution level to the minimum. Worldwide water bodies are primary means for disposal of waste, especially the effluents from industrial, municipal sewage and agricultural practices that are near them. This effluent can alter the physical, chemical, and biological nature of receiving water body (Sandoyin, 1991). The initial effect of waste is to degrade physical quality of the water. Later biological degradation becomes evident in terms of number, variety and organization of the living organism in the water (Gray, 1989). Often the water bodies readily assimilate waste materials they receive without significant deterioration of some quality criteria; the extent of this is referred to as its assimilative capacity (Fair, 1971). However, the water quality is deteriorating day by day due to anthropogenic input of dissolved nutrient and organic matter and industrial effluent, which is built up on its bank. So it is of vital importance to monitor and simulate the water quality parameters to ascertain whether the water is still suitable for various uses. Water contaminated by effluent from various sources is associated with heavy disease burden (Okoh, 2007) and this could influence the current shorter life expectancy in the developing countries compared with developed nation (WHO, 2002).

There is a wide variety of methods available for testing the microbial quality of drinking water through indicator organisms. The two most common methods that

are studied in detail in this thesis are the Presence/Absence (P/A) test and Membrane Filtration (MF) test. The P/A test is a simple method to identify the presence or absence of the indicator organism and is often indicated by a color change. While the P/A test may be adequate for detecting the presence of indicator organisms, it is unable to assess the extent of contamination in the water sample. The ability to enumerate indicator organisms is particularly important when assessing the performance of a water treatment device such as a water filter. It allows the researcher to calculate microbial removal efficiency by finding out how much of the indicator organisms are removed by the filter. However, the MF test is more elaborate in terms of its equipment and incubation requirements compared to the P/A test. There are also many kinds of culture media to choose from for the MF test. In this thesis, the most appropriate indicator test for monitoring the microbial quality of drinking water and assessment of filter efficiency will be proposed (Chian, 2002).

Fresh water resources are most precious to earth: they are the basic ingredient to life. Increased demands on the resources have impacted heavily on natural aquatic ecosystems. Fresh and pure water is limited in quantity indicates the need for comprehensive water management (WHO, 1992). So researches on the impacts of anthropogenial and techno-genial factors on fresh water resources are imperative. Such studies provide us with information of our limits in nature (Ray, 1992). We have several examples of civilizations, which have suffered by going into eclipse or extinction due, in great part, to a lack of stewardship and or knowledge of their water resources. The living communities of waters, their functional relationships, productivity, physical, chemical environment are all dealt in aquatic ecology. Study of all inland aquatic environments like; streams, rivers, lakes, reservoirs, and wetlands are called Limnology. The history of the discipline of Limnology dates back to Lake Geneva, the best known and one of the beautiful lakes in the world, since the 17th century. Bertola (1998), observed that between 1892 and 1904, Francois-Alphonse Forel, a Swiss naturalist carried out a major research work in this Lake and, laid the basis of Limnology.

As the supply of fresh water around the world continues to dwindle because of increased use and pollution, lakes of the world will undoubtedly be viewed as potential water reservoirs of convenience for human use (Odada *et al.*, 2004). The author emphasized that basic research on the lakes of the world lags far behind similar researches on the oceans. Lakes have a more complex and fragile ecosystem and they easily accumulate pollutants (Bhatt *et al*., 1999). According to him several characteristics of lakes make them ideal study sites to advance our basic understanding of ecosystem dynamics. Therefore, lakes in the world are in dire need of major new research initiatives. Bronmark and Hansson (2002) found that biodiversity of lakes and pond ecosystems are currently threatened by a number of human disturbances. The growing concern for environmental problems, implementation of new environmental strategies and administrations, international agreements, are positive signs of changes that should improve the ability to manage old as well as new, yet undiscovered threats in these systems. Lewis (1987) noted that in the absence of protective management, tropical lakes would decline greatly in their utility for water supply, production of commercially useful species, and recreation, because tropical lakes are more sensitive than temperate lakes to pollution. So management programs for tropical lakes will focus on interception of nutrients, protection of aquatic habitats from invasive species, and minimization of hydrological changes in rivers to which lakes are connected. The awareness of the scientific community and the public for fresh water systems will definitely serve as a function through collective opinions that is important to the determination of public policy, and consequent management of these systems. All these authors have thus emphasized the significance of ecological investigations of freshwater, especially that in the tropics.

2. THEORETICAL BACKGROUND

Factors that control the transport of bacteria's through porous media need to be thoroughly studied; transport of microbes in porous media implies that concentration may have accumulated at a very high degree. This is a serious concern to the study area, where permeability and porosity are of high degree, the study is in deltaic environment, where the geologic history has explain that the aquiferious zone are shallow depth deposition, generated a lots of hazardous sources of pollution either by manmade activities or natural origin, the condition of the deltaic environment, always developed a lots of contaminants from different sources, and this condition generated high degree of pollution from bacterial in the study area. Streptococci is the focus of this study, in deltaic environment the pollution of ground water through the porous media are from different type of soil, but the major influence of fast migration of microbes to ground water aquifers are from the deposition of the dynamic formation, the condition of the formation characteristics determine the rate of microbial transport from one region to the other. Application of plug flow reactors in soil and water details the sources of the contaminants from different dimensions. Base on this factors, mathematical model were developed through the consideration of this factors as a variables that influenced the migration of streptococci through soil formation, the model considered some major influence from geologic history in the deltaic environment that influence streptococci in the study location. The system where developed considering these major variables, and mathematical symbols were applied that represent the variables which determine the behaviour of the microbes in the study area.

3. GOVERNING EQUATION

The governing equation to monitor the rate of streptococci under the influence of permeability and

porosity in coastal area are expressed mathematical and derived bellow.

$$K\,C_{(x)}\frac{\partial V_{(x)}}{\partial t} = \frac{V\partial C_{(x)}}{\partial t} \quad (1)$$

$$\frac{V\partial C_{(x)}}{\partial t} = K\,C_{(x)}\frac{\partial V_{(x)}}{\partial t} \quad (2)$$

$$\frac{V\partial C_{(x)}}{\partial t} = -K\,C_{(x)}\frac{V_x}{t} \quad (3)$$

$$\left(\frac{V}{V_x}\right)\frac{\partial C_{(x)}}{\partial (x)} = -\frac{Kdt}{t} \quad (4)$$

EMBED Equation.3 (5)

EMBED Equation.3 (6)

EMBED Equation.3 (7)

EMBED Equation.3 (8)

EMBED Equation.3 (9)

EMBED Equation.3 (10)

EMBED Equation.3 (11)

EMBED Equation.3 (12)

The derived equation is to generate a model to monitor streptococci under the influence of porosity and permeability, integrating the concentration with the velocity of transport, equation 12 expresses the condition of the streptococci transport to the influence of velocity, the variables where found play a major role in the transport system of microbes in soil and water environment, for these reason equation 12 express the relation with the concentration of the microbes with respect to the period of transport at various formations.
The model can be applied to resolve the migration of microbial species streptococci influence on porosity and permeability. Integrating both parameters into the equation will yield:

EMBED Equation.3 (13)

Applying Laplace transform on (13) so that we have

EMBED Equation.3 (14)

EMBED Equation.3
=>

EMBED Equation.3 (15)
i.e.

we can use quadratic formula on (16) so that we can have;

EMBED Equation.3 (16)

With $S = K\,nV$, equation (16) can be expressed as

EMBED Equation.3 (17)

Now the general solution is

$$C_{(x)} = A\exp\left[\frac{-KnV + \left(K^2n^2V^2 + 4\beta KnV\right)^{1/2}}{2KnV}\right]t + \beta\exp\left[\frac{-KnV - \left(K^2n^2V^2 + 4\beta KnV\right)^{1/2}}{2KnV}\right]t \quad (18)$$

Subjecting equation (18) to the following conditions:
$x = 0$, $C_{(o)} = 0$ and $t = 0$, so that (18) gives a particular solution of the form

$$C_{(x)} = \exp\left[\frac{-KnV + \left(K^2n^2V^2 + 4\beta KnV\right)^{1/2}}{2KnV}\right]t - \exp\left[\frac{-KnV - \left(K^2n^2V^2 + 4\beta KnV\right)^{1/2}}{2KnV}\right]t \quad (19)$$

Using the expression EMBED Equation.3 ,

our equation (7) yields the result:

$$C_{(x)} = 2Sin\left[\frac{KnV + \left(K^2n^2V^2 + 4\beta KnV\right)^{1/2}}{2KnV}\right]t \quad (20)$$

The mathematical equation base on the entire entire variable where brought together, this form a system, denoting the parameters at various condition, the formulated governing equation, where derived to generate a model that will solve the transport of streptococci in coastal area of degema. The study area is a saline swamp mangrove area that deposited alluvium soil formation; the area is predominant with saline with short fresh water aquifer at shallow depths the rate porosity and

permeability are influence by the geological deposition of the area, short fresh water aquifer is the only affordable water borehole construction that is constructed for the people. In Most cases the ground water abstracted are not drill to the optimum, because study has told us that the deep fresh water aquifer are deposited above 600 meters, the type of ground water is capital intensive and cannot be easily achieved this model is imperative, because it will definitely assist the scientist and engineer to construct an economical bore hole that can generate quality water to the people.

4. CONCLUSIONS

Modeling the transport of streptococci in the coastal area of degema has been stressed, the model developed considering the influenced of several variable that causes fast migration of streptococci in the study location, formation characteristics is considered when developing the model, these variables formulated a system that generated the governing equation. More so the conditions are conceptualized base on other factors. This include the type of water we have in deltaic environment, this water are polluted by a lots of unsaved activities, consequently generating more water pollution in deltaic and other part of the country at large.

Nigeria has abundant water resources although they are unevenly distributed over the country. The highest annual precipitation of about 3, 000 mm occurs in the Niger Delta and mangrove swamp areas of the south-east, where rain falls for more than eight months a year. There is a progressive reduction in precipitation northwards with the most arid north-eastern Sahelian region receiving as little as 500 mm a -1 precipitation from about 3-4 months of rainfall. Widespread flooding occurs in the southern parts of the country, while the northern parts experience chronic water shortages during the dry season when rained springs, streams and boreholes dry up Groundwater resources are limited by the geological structure of the country IV.3), more than half of which is underlain by the Pre-Cambrian Basement Complex, composed mainly of metamorphic and igneous rocks. However, there are fairly extensive areas of fractured schists, quartzites and metamorphosed derivatives of ancient sediments from which water is often available at great depth. The sedimentary formations such as the Tertiary deposits of the Chad-Sokoto basins, the Cretaceous deposits of the Niger and Benue troughs, and the sedimentary formation of the Niger Delta, yield groundwater in varying quantities.

REFERENCES

Dwivedi B.K. and G.C. Pandey. 2002. Physico-chemical factors and algal diversity of two pondsin Faizabad, India Poll. Res. 21(3): 361-370.

Fair P. 1971. A Hypothesis concerning Silcia and fresh water plank tonic diatoms Limnol. Oceanogra. 16(1): 10-18.

Forenshell G. 2001. Setting basin design. Western Regional Aquaculture Center, WRAC-106. USA. p. 6.

Ghose F. and Basu P. 1968. Eutrophication trends in the water quality of the Rhode River. J. Mar. Biol. Assoc. 54: 825-855.

Gray A.V. 1989. Case study on water quality modelling of Dianchi Lake, Yunnan province, southwest China. Water Sci. Technol. 40: 35-43.

Gupta G. K. and Shukle R. 2006. Physiochemical and Bacteriological Quality in Various Sources of Drinking Water from Auriya District (UP) Industrial Area. Pollution Research. 23(4): 205-209.

Chapman D. 1996. Water quality assessments: A guide to the use of biota, sediments and water in environmental monitoring 2nd Ed. UNESCO, World Health Organization, United Nations Environment Programme, London, U.K.

Okoh A. I. 2007. Wastewater treatment plants as a source of microbial pathogens in the receiving watershed. Afr. J. Biotech. 6(25): 2932-2944.

Okoye P. A. C., Enemuoh R. E. and Ogunjiofor J. C. 2002. Traces of heavy metals in Marine crabs. J. Chem. Soc. Nigeria. 27(1): 76-77.

Pandey. 2003. Trends in eutrophication research and control. Hydrol. Proc. 10(2): 131-295.

Lowel and Thompson F. 1992. Biodiversity of vibrios. Microbiol. Mol. Biol. Rev. 68: 403-431.

Singh RP and Mathur P. 2005. (Dept Environ Std, MDS Univ, Ajmer 305 009). Investigation of variations in physico-chemical characteristics of a fresh water reservoir of Ajmer city, Rajasthan. Indian J. Environ Sci. 9(1): 57-61.

WHO. 2002. Water and health in Europe: A joint report from the European Environment Agency and the WHO Regional Office for Europe. World Health Organization, WHO Regional Publications, European Series No. 93.

Patil Dilip B and Tijare Rajendra V. 2001. Investigation of pollution mystery of suspected carcinogen Cr (VI) and its control. Department of Chemistry, Govt. Sci Coll, Gadchiroli 442605. J. Indl Polln Contl, 17(1): 43-47.

Sandoyin. 1991. Eutrophication trends in the water quality of the Rhode River. J. Mar. Biol. Assoc. 54: 825-855.

Katsuro A., Yashiko K., Yoshinnori S., Takashi T. and Hayao S. 2004. Heavy - metal Distribution in River Waters and sediment a firefly village Shikou, Japan: Application of multivariate Analysis. Analytical science,

20: 79-84. Miller and siemmens. 2003. Anal. Chem. 31: 426-428.

Chian Siong Low. 2001. Appropriate Microbial Indicator Tests for Drinking Water in Developing Countries and Assessment of Ceramic Water Filters. M.Sc thesis, Massachusetts Institute of Technology. pp. 1-12.

WHO. 1992. Our planet our health- report of the WHO commission on health and Environment, Published by WHO, Geneva. pp. 130-131.

Ray J. G. 1992. The influence of anthropogenial factors on the stability of steppe biogeocoenoes on the mid-dnieper watersheds in Ukraine. Ph. D thesis, Dniepropetrousk State University, Ukraine. p.155.

Odada E. O., D. O. Olago, K. Kulindwa, M. Ntiba and S. Wandiga. 2004. Mitigation of environmental problems in Lake Victoria, East Africa: Casual chain and policy options analyses, Royal Swedish Academy of Sciences-Ambio. 33(1-2): 13-16.

Hakanson L., A. Ostapenia, A. Parparov, K. D. Hambright and V. V. Boulion. 2003. Management criteria for lake ecosystems applied to case studies of changes in nutrient loading and climate change. Lakes and Reservoirs: Research and Management. 8: 141-155.

Lewis W. M. Jr. 1987. Basis for the protection and management of tropical lakes. Lakes and Reservoir: Research and Management. 5: 35-48.

Bertola C. 1998. Francois-Alphonse Forel (1841-1912): founder of Swiss Limnology, Archives Des Sciences. 51(1): 131-146.

Bhatt L. R., P. Lacoul, H. D. Lekhak and P. K. Jha. 1999. Physico-chemical characteristics and phytoplanktons of Taudaha Lake. Kathmandu, Poll. Res. 18(4): 353-358.

Jithesh k. 2008. Re investigation on hydrobiology and water quality parameters of Periyar Lake, Thekkady, Kerala. Ph. D dissertation, Environmental science research lab department of Botany, St. berchmans college Changanacherry, Kerala, 686101.

Richard H and Ivanildo H. 1997. Water Pollution Control - A Guide to the Use of Water Quality Management Principles, Published on behalf of the United Nations Environment Programme, the Water Supply and Sanitation Collaborative Council and the World Health Organization by E. and F. Sponsor © 1997 WHO/UNEP ISBN 0 419 22910 8.