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Research article

MATHEMATICAL MODELING ON APPLICATION OF BATCH SYSTEM TO PREDICT THE DEPOSITION OF BACTERIAL IN LAKES

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ABSTRACT

public health concern are also on several rate of pollution in most lakes, the problem are mostly associated with indiscriminate dumping of waste and poor environmental sanitation, untreated biological waste are directly into the lakes, high rate of aquatic degradation has been found in lakes, most marine habitation were confirm to have reduce due increase of death rate through constant regeneration of biological waste dischargininto the lakes. this has cause a lots of illness to human, several illness are generated from poor sanitation in the study area, other influence are climatic condition that develop high ran intensities, these play some roles in constant regeneration that deposit bacterial from biological waste discharging directly without treatment. This condition were considered before mathematical equation was develop, the equation were derived and it generate a model to monitor the deposition of bacteria on batch system application in a lakes, the study is imperative because high degradation of some marine habitation are cause by this pollution from these sources.

Keywords: Mathematical modeling, batchsystem, deposition of bacterial and lakes

1. Introduction

The lakes and reservoirs represent very complex and fragile ecosystems. As part of the industrial development in most places fresh water bodies are dumped with highly toxic chemicals along with effluents, to a dangerous level. Nutrients washed down from the irrigated fields and drainage channels reach our freshwater bodies (Chapman and Reiss, 1995).Studies of fresh water systems, and the human impact on such systems, are quite timely. Such studies pave the way to prime regulatory mechanism for the ecosystem as a whole, and may reveal both the rate and direction of whatever changes take place within the system (Varshney, 1989). The biodiversity and dynamics of

different phytoplankton populations, and their role in natural water cycle, are one of the least explored areas in Aquatic Biology. All the developmental activities have immediate effects on various water quality parameters, including hydrobiology. World's lakes and reservoirs are distributed in Africa-31240 km3, Europe- 2449km3, Asia-29132km3, Australia-192km3, North Ammerica-26573km3, and South Ammerica-1199km3 respectively (Korzun *et a*l., 1978). Lakes and wetlands have been recognized worldwide as extremely important biogeography zones (Nameer, 2005). These lentic water bodies are common and stable habitats of the biosphere (Radhika *et al*., 2004). In spite of the fundamental importance of lakes, reservoirs, and wetlands tohumans as life-supporting systems, and as systems providing recreation facilities for the people, these have severely been affected by a multitude of anthropogenic disturbances which have led to serious negative effects on the structure of these ecosystems worldwide (Bronmark and Hansson, 2002).

Freshwater 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 *Muhibbu-din et al , 2008*). 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 as 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 Siemmens 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 *Muhibbu-din et al , 2008*). The occurrence of heavy of 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 fromindustrial, municipal sewage and agricultural practices that are near them. This effluent can alterthe physical, chemical, and biological nature of receiving water body (Sandoyin, 1991 *Muhibbu-din et al , 2008*). The initial effect of waste is to degrade physical quality of the water. Later biological degradationbecomes 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). Due population explosion and moderate to rapid urbanization, people rely heavily on water sources of doubtful quality in the absence of better alternatives, or due to economic and technological constraint to adequate treat the available water before use (Anna and Adedipe, 1996; Calamari and Naeve, 1994).The scarcity of clean of water and pollution of fresh water has therefore led to a situation in which one – fifth of the urban dwellers in developing countries and three – quarter of their rural dwelling population do not have access to reasonably safe water supplies (Lloyd and Helmer, 1992). Effluents are composed mainly of either organic, inorganic matter or both and toxic substance depending on it source. Inorganic matter in effluent are formulated using various chemical containing nitrogen, phosphorus and potassium. These element especially phosphorus stimulates the growth of microscopic plant while nitrogen promotes overgrowth of aquatic vegetation which degrades water quality. Potassium promotes productivity of aquatic animals such as fish (Wurts, 2000 *Muhibbu-din et al , 2008*). Organic matter in effluent are formulated using various chemical containing Carbon, Nitrogen and Phosphorus. Organic matter promotes the growth of zooplankton as well as macro benthic invertebrates (Adigun, 2005). Organic matter also stimulates the growth of decomposers such as bacteria and fungi. Bacteria and fungi are very critical to the breakdown of the toxic component of the effluent. It has been observed that dissolved oxygen in water is required during the decaying of the organic matter, which may lead to depletion of oxygen in the water body and cause harmful substance to accumulate (Watson and Cichra, 2006) *Muhibbu-din et al , 2008*.

2. Theoretical Background

Surface water is found to contain different constituents that will be good for aquatic life. Varieties of organisms in natural water vary greatly in different places and under different conditions; bacteria are washed into surface water from rain. Most surface water is polluted from different sources, but the most common one is discharge of biological waste and spillage of hydrocarbons. These develop a lot of bacteria that will be harmful to the marine environment. Surface water has some criteria that will be harmless to marine biota. Physiochemical properties of water are being degraded through this pollution of surface water. This studies center on lake, most wastes are being discharged into lakes through indiscriminate dumping. This generate lots of pollution, it decrease the physiochemical property of lakes where the pH values will decrease through the influence of these pollutants. This will definitely make the surface water in the lake to be acidic and it will affect the aquatic life in the marine environment. The threat has generated lots of degradation of marine biota. Other source of pollution of lake are waste that are directed through our drains which discharge directly to our lakes, constant generation from this point source has also increases higher concentration of bacteria in the lakes. Several aquatic lives have been affected through constant regeneration of bacteria concentration into the lakes. Based on this fact, several aquatics liveshave been degrading through these sources. This noticeable ugly siege has resulted to constant increase of pollution reducing the aquatic life's span and reproduction, thereby causing the migration of aquatic habitat to other marine environment. To reduce this source of pollution, mathematical model were developed to monitor the rate of bacteria deposition in a lake. The model was developed through modified governing equation that expressed the deposition of bacteria in a lake. Influential parameters that expressed the exponential rate of bacteria in a lake were considered in the system. This

parametersmodified the equations that are derived to solve this problem, the generated equation for bacteria depositions in the lake are stated below.

$$K\,C(x)\frac{\partial v(x)}{\partial t} = V\frac{\partial c(x)}{\partial t} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

The governing equation is an expression developed to monitor the rate of bacteria deposition in lake this mathematical equation were developed considering some influential parameters that deposition in lake, the equation were developed considering the influential variables that played a major role in the system. The variables can monitor the concentration in such environment stated in equation bellow.

$$K\frac{\partial c(x)}{\partial t} = K\,C(x)\frac{\partial v(x)}{\partial t} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

$$V\frac{\partial c(x)}{\partial t} = -K\,C(x)\frac{vt}{t} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

$$\left(\frac{V}{Vx}\right)\frac{\partial c(x)}{\partial (x)} = -\frac{Kdt}{t} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (4)$$

$$V/V - \int 1/(x)\ \partial c(x) = -K\int\frac{\partial t}{t} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (5)$$

$$V/V_{(x)}\left[\ln C(x) = -K\ln\frac{t_o}{t}\right] \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (6)$$

$$\ln\frac{C_{(x)}}{C_{(x)}} = -K\frac{V_{(x)}}{V}\ln\frac{t}{t_o} = \ln\left(\frac{t}{t_o}\right) - K\frac{V_x}{V} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (7)$$

$$\frac{C_{(x)}}{C_{(x)_o}} = \left(\frac{t}{t_o}\right) - \frac{KV_x}{V} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (8)$$

$$\frac{C_{(x)}}{C_{(x)_o}} = \ell^{-K\ln\left(t/t_o\right)V_x/V} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (9)$$

$$\frac{C_{(x)}}{C_{(x)_o}} = \ell^{-K\ln 1/t\,V_x/V} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (10)$$

$$C_{(x)} = \beta\,\ell^{-K\ln 1/t_o} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (11)$$

Where

$$\beta = C_{(x)_o}\ell^{-K\ln 1/t_o}$$

…… (12)

The developed equation were derived to express there various variables in terms of there functions in the system, the derivation generated a model as expressed in (12), whereby concentration with respect to time were expressed under the velocity of transport in the system. The derived model in this system implies that deposition of these microbes in lake, implies that velocity of flow will be transient. Microbial deposition in such marine environment can only deposit low concentration when micro element are not found in such environment, indiscriminate dumping of biological wastes are the challenges in such environment under the influence of manmade activities. The chances of not depositing bacteria in the environment become very slim, because there is the tendency of waste generation in the, these are found to deposit through drain directly to the lake in the study area. The action from manmade activities is a subject of environment concern on public health, because the major degradation of our aquatic life span are from biological wastes that are directly discharge in the lakes caused by untreated wastes in the environment.

The model can be applied to monitor the rate of bacteria deposition on a batch system.

This implies that the contaminant is more proportional to time.The model can be applied in waste dump site. But considering the equation in a condition of Batch System of a lake it is expressed in these form.

$$\beta C(x)^{Vx}\!/_{tv} \Rightarrow C(x) \quad \beta - {}^{Vx}\!/_{tv} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (13)$$

Taking Laplace transform of the equation

$$Co = \frac{\beta}{\frac{V_{(o)} + S}{V}} \Rightarrow C_{(o)}\left[\frac{Vo}{V} + S\right] \beta \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (14)$$

$$C_{(o)}\ V_{(o)} + S\,C_{(o)}\ V = \beta V$$

$$C(o)\,V(o) + S\,C_{(o)}\ V - \beta V = 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (15)$$

Further expression were made in the system, is to descretize other variables that express their influence in the system, quadratic expression were applied to ensure that the function of the variable are thoroughly expressed. The equation displayed there roles, thus other independent variables applied in the system were integrated; this is to streamline the behaviour of the concentration under degradation and exponential level on transport process in lake. The applications of quadratic expression definitely express the behaviour of bacteriadeposition in this phase.

Applying quadratic expression we have

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Where *a = Vo, b = Sv and –Bv*

$$=> C_{(x)} = \frac{-Sv \pm \sqrt{S^2V^2 + 4\beta}}{2v}$$

$$C_{(x)} = \frac{-Sv \pm \sqrt{S^2 + 4\beta}}{2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (16)$$

But $\frac{VC_{(x)}}{V}$ for S in (16) give

$$C_{(x)} = \frac{\frac{VC_{(x)}}{V} \pm \sqrt{\frac{V^2{}_{(x)}}{V^2} + 4\beta}}{2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (17)$$

$$=> \quad C_{(x)} = \frac{-1 \pm \sqrt{\frac{V^2{}_x}{V^2} + 4\beta}}{2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (18)$$

$$=> \quad C_{(x)} = A\ell^{\left(-1+\frac{\sqrt{1+4\beta}}{2}\right)^t} + \beta\ell^{\left(-1-\frac{\sqrt{1+4\beta}}{2}\right)^t} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (19)$$

Integrating the boundary condition in this condition at t = 0, C(o) = (o), t = (o)

Therefore equation (2) becomes

0 = A + B => A = - B

If *A = 1 => B = 1*

Therefore the model equation can be expressed as

$$C_{(x)} = \ell^{\left(-1+\frac{\sqrt{1+4\beta}}{2}\right)^t} + \ell^{-1\left(-1\frac{\sqrt{1+4\beta}}{2}\right)^t} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (20)$$

The expression at (20) considering all the variables in the system, the developed model expressed all the variables that influence the transport system of bacteria Deposition Lake, since lake are batch system every microbes deposited in a particular environment has a limited area to move. The batch system was applied in developing the mathematical equation that governs the deposition of bacteria in a lake. The influences are from regeneration of waste through constant discharge from drains. Theconcentration developsrapid microbial growth if there is deposition of micro element in the lake. The expression at this phase implies that constant discharge of this

bacterium from drains and other sources will always increase the bacterial and degrade the required physiochemical parameters.

3. Conclusion

Bacterial; deposition in lakes are through the indiscriminate dumping of biological waste in lakes. Several aquatic lives that settle in the marine environment has been severely affected due this ugly siege. Most biological waste are dumped into the lake without treatments, this condition has resulted to degradation of most physiochemical constituent of the water in the lakes, this affect the habitats in several condition.

The development mathematical model expressions werederived under this condition to monitor the rate of concentration under exponential condition, constant discharge of biological waste from a point sources discharge were observed. This condition has been the major threat to the settlers in the environment, the rate of marine habitation are experiencing serious degradation because every thing in the lakes that made up marine habitation are severely affected,Environmental factors were considered in the system due to environmental influence in the study area,because environment influences like climatic conditions develop high rain intensities thus generating constant regeneration of biological waste through the drain, this dimension has some influence on the life span of the marine habitation, whereby high rain intensities increase the concentration of the bacterial through the drain that will always produce this waste from numerous direction,

To monitor the rate bacterial deposition in a lakes mathematical equation were developed through the influential variables in the system. developed mathematical equation were derive and it produced the model that will monitor the deposition of bacterial in lakes , the model developed will be useful to experts in to prevent the pollution source, this will go a Longe way in preserving aquatics and also maintaining the water quality of our lakes .

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