Comprehensive Review Design and Analysis of Mathematical Modeling for the Concentration of Pollution and River Water Quality

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Abstract
One of the key components of the environment that determines the existence of life on Earth, influences the climate, and restricts the growth of civilisation is water. The management of water resources necessitates ongoing evaluation of its qualitative and quantitative metrics. The key to properly determining the extent of water contamination is the foundation for water resource conservation and intelligent use. Lake and dam water quality is changing. Continual deterioration brought on by natural processes as a result of eutrophication and human-caused reasons. Modelling of changes is one of the methods used to address the issue of surface water contamination happen in lake waters, changing the water's quality in the process. During the last 30 years, a quick development of the quality of water resources has been modelled mathematically. In order to give a solution utilising mathematical modelling, this paper also aims to summarise the negative impacts of water pollution and the threat to aquatic species. The recently created models assist us in anticipating changes in water quality and in preventing future harm. The physical, chemical, and biological characteristics of water are being harmed by the release of untreated waste, sewage, dissolved oxygen, bacteria, and harmful chemical compounds from industries, as has been closely examined in this work. The paper includes various references to assist illustrate this in explicit detail. There is also discussion of the biochemical oxygen demand, nutrients, pH levels, and the process of self-purification in water bodies. The mathematical ideas used to solve non-linear differential equations in one-dimensional environments.

Keywords: Mathematical model, Advection-diffusion equation, water pollution, water quality.

1.INTRODUCTION

One of the key components of the environment that determines the existence of life on Earth, influences the climate, and restricts the growth of civilization is water. The management of water resources necessitates ongoing evaluation of its qualitative and quantitative metrics. Water resource conservation and intelligent use are based on an accurate evaluation of the level of water contamination. Lake and dam water quality is continuously declining as a result of eutrophication-related natural processes as well as manmade factors. The modelling of changes that occur in lake waters and related changes in water quality is one of the methods used to address problems with surface water pollution [1]. The mathematical modelling of the quality of water resources has advanced quickly during the past thirty years. Many computer models have been created, and they are effectively used in many different nations today. An ecosystem is made up of humans, plants, animals, microbes, and their surroundings. The term "environment" refers to all physical, chemical, and biological factors that have an impact on an ecosystem [1]. Special geographic and biological characteristics like soil, climate, flora, and fauna result in a wide range of different ecosystem types, including forests, fields, and the ocean. Ecological and environmental disturbances that are irregular and unexpected can upset the balance and possibly wipe out the ecosystem. Any unfavourable changes in the physical, chemical, or biological features of any element of the environment that have the potential to have a negative impact on a variety of living forms and attributes are referred to as environmental pollution. Water contamination is one of the main categories of environmental pollution.

Water pollution is a daily occurrence and affects the most vital element for life on earth. The difficulty with this is becoming worse. The discharge of untreated waste, sewage, agricultural runoff, and toxic metals causes the water bodies to become contaminated. The result is that the contaminants taint the receiving water with colour, flavour, and odour, rendering it unsuitable for human consumption. The organic material in the faeces reduces the water's oxygen concentration. Pollutants have the following negative consequences on the environment: The immediate effects of the toxicant on the creatures are their deaths, which can be experienced and analysed more easily. Pollution affects species in the most obvious way. Pollutants may also have an indirect impact on a species by eliminating a different species in the food web or food chain, which would then cause the trophic structure to become unstable. The most difficult issue facing society is the change in the environment brought on by pollution, which has an impact on human lifestyle, the biodiversity of the habitat, and the long-term survival of aquatic species [2]. A significant amount of toxicants and contaminants are continuously introduced into ecosystems, endangering the survival of the exposed population, including humans. Many different kinds of hazardous metals that are released from industry and agricultural lands are polluting the aquatic environment. Heavy metals and radioactive materials are the main pollutants that the industries create. To increase productivity and combat plant diseases, fertiliser, herbicides, and insecticides are used in agriculture. Aquatic life is harmed when hazardous metal-containing fertilisers, herbicides, and insecticides enter water bodies through surface runoff. In a nutshell, the impacts are briefly outlined, and remedies employing mathematical modelling are recommended [3].

The modelling of changes that occur in lake waters and related changes in water quality is one of the methods used to address problems with surface water pollution. By taking into consideration changes that alter water quality parameters or changes in their intensity, such a model may be used to forecast water quality. In many nations, residential or industrial human activity-related water contamination is a serious issue. About 25 million people each year pass away as a result of water contamination. The amount of dissolved oxygen, the presence of nitrates, chlorides, and phosphates, the level of suspended solids, environmental hormones, chemical oxygen demand, such as heavy metals, and the presence of bacteria are just a few of the variables to take into account when evaluating the water quality in a river. Surface and groundwater quality deterioration can be significantly attributed to pollutants from agricultural operations [1]. The first mathematical water quality models date back to Streeter and Phelps' well-known model from 1925, which addressed the equilibrium of dissolved oxygen in rivers [5]. Eutrophication, acute and chronic toxicity, and other issues related to surface water contamination were mathematically explored by Rauch et al. [8]. In order to study the impact of aeration on the degradation of pollutants, Pimpunchat et al. [7] presented a straightforward mathematical model for river pollution. Their model consists of a pair of coupled reaction-diffusion-advection equations for the concentrations of the pollutant and dissolved oxygen. Equation of advection and diffusion. Many mathematical models on river pollution have recently been published in the literature [2], [3], [4], [9], and [10].

2. MATHEMATICAL MODEL

The following list [2] represents the broadest division of software modules used to simulate environmental processes:

A. Actual objects (laboratory)

B. mathematical representations, such as analytical models based on precise answers to mathematical equations physics, using approximate solutions for numerical models. Depending on how intricate the surface water quality computer simulation models are, Three groups can be made of them: One-dimensional (1D) models, the most basic and widely used models in the analysis of river water quality based on the supposition that major changes in the parameters Only along the longitudinal profile of the watercourse can the quality of the water be determined. The foundation of one-dimensional inflow-outflow models is the measurement of the concentration several water characteristics entering and leaving. Consequently, modifications to the Calculations are made for all parameter concentrations. Unreliable are one-dimensional models designed to estimate the fluctuation in concentration at the moment, hence one cannot obtain precise details on the hourly, daily, and monthly water quality indicators. These The intricate chemical, physical, and biological interactions that take place in Reservoirs of water that are crucial for managing changes in water quality parameters. The ability to swiftly apply these programmes to any situation is a benefit of these alternative water reservoir with a limited database of relevant data and no pre-calibration [5] measurements.

Two-dimensional (2D) models, which presuppose that substantial changes in water quality occur not only along the stream but also in its longitudinal profile, and consequently, it is vital to evaluate the quality of the water at various depths. Two-dimensional. When it comes to deep rivers, lakes, and reservoirs, models are most frequently utilised, and they require compared to one-dimensional models, greater information and user analytical experience. Since many of their parameters are sensitive to changes, they need careful calibration. A prediction of the parameters affecting water quality is the program's final output. Close to real concentration readings evaluation of each unique parameter can be carried out for certain time periods, such as an hour, day, week, month, and year [5]. Models in three dimensions (3D), which look at the geographical distribution of concentrations of water-quality parameter simulations. Models in three dimensions include utilised to model variations in water quality in lakes, dams, deep rivers, and sea bays; They demand a user with considerable analytical skills and access to enormous volumes of data. Because the topics under analysis are so complicated, they are rarely employed. Similar to other environmental sectors, surface water quality computer modelling

Problems necessitates an interdisciplinary approach using current mathematics and use of computer technology and fundamental methods coexist in the subject of engineering in the environment. This is true for the explanation of natural events connected to the production of pollutants, their dispersion, and the modifications that occur. The use of computational techniques, and take occur in the aquatic environment models for hazard assessments or water quality control in certain circumstances [2].

The model's ultimate objective from the perspective of applications is to be used as a helpful tool while making planning choices. Surface water quality is being observed and forecasted. There are numerous sorts of models that are taken into account because of the scope and spatial scale: Operational models are frequently employed in real-time forecasting and are connected to short-term projections. Regulation of water reservoirs or flow rates to keep set standards intact. Such models call for the automated entry of the most recent input data. Tactical models, which are linked to the use of operational decision-making in taking tactical moves that include "input-output" linkages between the major players, the system's settings are crucial. This kind of analysis's temporal range includes a few days, a few weeks, or even a season in the case of water control character of a river. When it comes to the tactical model's tools, steady-state analysis and instruments of quantitative economic and environmental analysis are most often utilised. b) Strategic models: they refer to a longer time frame in which analysis, forecasting, or planning is performed. Plan the environment's status as a projection of the existing state, taking into consideration every essential trend. This kind of modelling is founded on an examination of the outcomes of analyzing the effectiveness of various scenarios using computer simulation d) Directional models, which deal with long-term structural change projections and evaluate the potential for sustained growth as well as systemic transformation. Modelling changes in the environment is done with the help of well-picked calculating programmes. a watery setting. They mimic the way the aquatic environment behaves and the manner in which its specifications alter. These variables consist of the following: water temperature, wind speed and direction, dissolved oxygen concentration, water salinity, and the quantity of biogenic Depending on a program's complexity, compounds and other parameters may be used [4]. In 1925, the United States produced the first surface water quality model in the world. of America, by Streeter and Phelps, to plan the placement of the sewage drainage system for the Ohio River's outfalls [3]. The model was one-dimensional and based on the equilibrium of simple linear equations and oxygen. Even though more than 80 years have passed since then, the fundamental methodology for modelling surface water quality has not altered. All models are based on three fundamental ideas: the conservation of mass, momentum, and energy; and power. The dynamics are described by ordinary and partial differential equations. Occurrences in the surface waters are linked to the spread of different contaminants. In the considered control volume and time interval, each physical quantity's general The following is the law of conservation [2]: accumulation: inflow outflow plus a cause of change. According to estimates, there are now at least a few thousand surface water quality models that are derived from basic modules that are made available or sold and then modified for the model stream or water storage facility [3]. In the discipline of modelling surface water, the United States of America is at the forefront. Employing its own, most advanced surface continuous monitoring network in the world's waters. The use of one-dimensional and two-

dimensional models in research is widespread. Centres and state or federal institutions. Three state entities play the largest roles: the United States Geological Survey, the EPA (United States Environmental Protection Agency), and the Waterways Experiment Station, which are all part of the United States Army Corps of Engineers. Although European advancements in this field are likewise noteworthy, unrestricted access to the documentation, programming language, and various examples for the American models advocates the selection of models produced in the United States because of their practical usefulness [4]. Below is a quick overview of a few surface water models. The PC-based ecosystem model AQUATOX 2.2 forecasts the fate of nutrients and the direct and indirect effects of sediments and organic compounds in water bodies on the local creatures. AQUATOX replicates the movement of biomass and chemicals from one ecological component to another. It achieves this via computation of critical biological and chemical processes throughout time. AQUATOX replicates a variety of environmental stresses, such as organic temperature, hazardous substances, and loadings, and how they affect the algal, fish, invertebrate, and macrophyte communities. AQUATOX can assist in locating and comprehending the connections between chemical water quality, environmental factors and aquatic life. Many different aquatic environments may be represented by it; lakes, ponds, and reservoirs with vertical stratification, as well as rivers and streams, and now estuaries. CE-QUAL-ICM is the result of the evolution of a 3D water quality model created for Chesapeake Bay that will assess the impact of proposed nutrient reduction measures on the Bay. There is a bottom sediment chemistry sub model in this model. It interacts with the water column to simulate the oxygen and nutrient needs for the sediment fluxes. In order to use the CE-QUAL-ICM modelling technique, a 2D or 3D driver must drive the CE-QUAL-ICM with the output of the hydrodynamic model transit lingo. The water quality model may then be used under various circumstances. avoiding the necessity of running the hydrodynamic model again. Using the CE-QUAL-ICM model, employed on several systems, including the Lower Hudson, the New York Bight, and the Chesapeake Bay, Green Bay, Long Beach Harbour in Los Angeles, and Rehoboth Bay on the Indian River. — The CE-QUAL-RIV1 1D one-dimensional (cross-sectionally averaged) hydrodynamic model resolves longitudinal fluctuations in both water quality and quantity. Where lateral and vertical movement are present, it has hydraulic and quality features. Small differences exist. There are two elements to CE-QUAL-RIV1: a hydrodynamic code (RIV1H) and a code for water quality (RIV1Q). First, the hydrodynamic code is used to anticipate water transport, with its outcomes recorded in a file that is read by the excellent model. One-dimensional hydraulic and water quality predictions may be made using it. Forecasting under steady-state conditions requires changes in streams and rivers with extremely erratic flows. Riv1H forecasts flows, depths, and speeds. Elevations at the water's surface and other hydraulic properties. The common model of hydrodynamics uses the commonly used method to solve the St. Venant equations as the governing flow equations. Accepted four-point finite difference numerical technique
RIV1Q can forecast differences between each of the 12 state variables: temperature, biological carbonaceous oxygen Organic nitrogen, ammonia nitrogen, nitrate(V) + nitrate, demand (CBOD) (III) Algae, dissolved phosphates, organic phosphorus, dissolved oxygen, nitrogen coliform bacteria, dissolved manganese, and iron. CE-QUAL-W2 2D is a 2D (longitudinal-vertical) water quality and hydrodynamic model for rivers, estuaries, lakes, reservoirs, and river

basin systems. The USACE Waterways Experiments Station supports this two-dimensional water quality and hydrodynamic code [6]. Stratified data has seen extensive use of the concept. surface water systems, including estuaries, lakes, and reservoirs, and calculates water temperature, levels, horizontal and vertical velocities, and 21 additional water quality parameters factors (including the amount of dissolved oxygen, nutrients, organic matter, algae, pH, and the bacteria, the dissolved and suspended solids cycle, and the carbonate cycle). — COASTOX, a simulation model created by the Kiev Cybernetics Center [7] pollutant movement and dispersion in the Dnieper reservoirs and in the River Pripyat. It has radionuclide transport sub models that are comparable to those found in FETRA. The model incorporates the transfer of silt, the transport radionuclide-sediment interactions, advection-diffusion, and. It explains the pace of sedimentation and the dynamics of the bottom depositions. Resuscitation with relation to the gap between the real and equilibrium concentration of the suspended stuff based on the flow's ability to convey it. — DELFT 3D is an extensive system for modelling coastal hydrodynamics that is capable of simulation of wave, tide, river, wind, and coastal hydrodynamic processes currents. It is a collection of software tools for three-dimensional calculations created by Delft. Hydraulics. Software called Delft 3D was created primarily as an application centered on water quality and flow. The package includes a number of modules. Combined to present a comprehensive representation of three-dimensional flow, surface waves, ecology, water quality, transit of silt, and bottom morphology in challenging, coastal regions. Hydrodynamic modelling is a component of the system. Modules for flow, water quality, waves, and particle tracking module-PART, sediment transport module-SED, and morphodynamic MOR module ECO, the ecological module. — A computer programme called DUFLOW 1D simulates 1D unsteady flow and water. Quality in public waterways. Simulates water quality and flow, excellent for modelling the flow of chemicals on loose surfaces; transitioning away from Analysis of phenomena and processes is made possible by bottom substances. Between the elements present in the sediments and those dissolved in the water. DUFLOW has been successfully implemented in a number of river systems [8]. UNFLOW is capable of working with geographic information systems, which make representation and the open water system is displayed. Dynamic Reservoir Simulation Model 1D (DYRESM 1D) is a one-dimensional Predicting the vertical distribution of temperature and salinity using a hydrodynamics model and densities in lakes and reservoirs that approximate one dimension. The Flow Science Inc. did a model study. DYRESM offers measurable benefits predictions of the thermal properties in such systems across time scales that can be verified varying between a few weeks to tens of years. Thus, the model offers a way of forecasting lake and reservoir seasonal and inter-annual fluctuation as well as testing for sensitivity to long-term changes in the environment or watershed properties. DYRESM can be used for experiments that are just hydrodynamic ally isolated or CAEDYM (Computational Aquatic Ecosystem Dynamics Model) is connected for Biological and/or chemical process-related research. The mathematical of DYRESM are rather low, and multi-year simulations may be run on PC systems running Linux or Windows. — ECOM (Estuarine, Coastal and Ocean Model) It has three dimensions and Blumberg and Mellor [9] created a time-dependent model for shallow water. rivers, lakes, estuaries, and ocean coasts are examples of aquatic ecosystems. Since the recent It has been the most widely used model for calculating flow simulations in coastal areas for years. Lakes and waterways. — FLESCOT is a three-dimensional, finite difference model that is unstable [10]. It comprises of sub-models for water temperature, salinity, turbulence, hydrodynamics, Cohesive and non-cohesive sediments as well as dissolved and particulate pollutants sediment-sorbed). Additionally, the FLESCOT model mimics how sediments behave. Toxins in the riverbed, which are impacted by erosion and deposition, as well as direct bioturbation and the adsorption/desorption of water and sediments at the bottom. It can determine how waves and wind-induced flow will impact the movement of sediment. Transport of pollutants in shallow water. The Hudson has been used as the model. New York river estuary for Cs-137 buildup and migration, to Buzzards evaluating the effects of PCBs and heavy metals in Massachusetts' Bay/New Bedford Harbour transfer, future cleanup efforts, and probable 3000-meter-deep ocean for the evaluation of low-level radioactive waste disposal. FLESCOT utilizes many beds layers. — The US EPA analysis tool HSPF (Hydrological Simulation Program - FORTRAN) developed to enable the engineer to mimic water quality and hydrology in natural and artificial systems. When using mathematical simulations to simulate the pollution flow via watersheds. It is a group of codes for computers that can On pervious and non-pervious surfaces, simulate the hydrologic processes and related water quality streams, impervious land surfaces, and well-mixed impoundments. — MIKE-3, a software programme and three-dimensional model that is used in the form by the Danish Institute of Hydrodynamics' computer programmers. This permits The modelling of any surface water system considers both water flow and its quality, permits modelling of nutrient transport and metabolism, heavy metal metabolism, the occurrence of bottom processes, bottom flooding, and drying troughs sediments. Mike-3 is built in a modular fashion from three major parts: oceanography and estuarine and coastal hydraulics sediment hydraulics in the environment processes. The Advection-Dispersion module is one of the category of environmental modules. Water Quality Module (WQ), the Air Quality Module (AQ), and three process modules Heavy Metal Module (HM) and Eutrophication Module (EU) (ME). — The Danish Hydraulic Institute's MIKE 11 programme [11] is a system for one-dimensional modelling that simulates flows, sediment transport, and Estuaries, rivers, irrigation systems, and other bodies of water all have good water quality. It has been created with a modular framework that integrates with simple computational modules for water quality, advection-dispersion, hydrology, and transport of cohesive and non-cohesive sediment. Additionally, the system has a module for the evaluation of rainfall runoff. The software allows for the investigation of flood events, Real-time flood forecasting and prevention design MIKE 11 allows for analysis as well. of dam failures, reservoir planning, and hydraulic machinery. In addition, a useful tool for calculating how much water affects the ecosystem around us. Lake and reservoir water quality is modelled by MINLAKE 1D. It is made to compute. Criteria for water quality include temperature, dissolved oxygen content, and the concentration of dissolved chemicals, nitrogen, and phosphorus. — TELEMAC is a sophisticated system that computes the finite element technique. Pollutants' movement and the state of the water in two and three dimensions. This programme was created by HR Wallingford and Electricity de France. France/SOGREAH. The most popular are TELEMAC, MIKE-3, and Delft3D. Popular software programmers that are sold commercially for the three-dimensional flow, transport, and water quality calculations. — The WASP modelling system is part of the WASP

(Water Analysis Simulation Program). a framework for generic modelling of pollutant fate and movement in surface waters waters. WASP can be used in one, two, or more compartments based on flexible compartment modelling. or the third dimension. WASP is intended to make user-written content replacement simple. Procedures into the design of the application. Issues that have been investigated with WASP include dissolved oxygen dynamics, biochemical oxygen demand microbiological contamination, nutrient/eutrophication, and harmful chemical transportation. WASP is a dynamic compartment model that may be applied to examine various water sources. Quality issues in ponds, streams, lakes, reservoirs, and other types of water bodies, rivers, and ocean waters.

3. METHODOLOGY

Mathematical modeling on water pollution and self-purification of river Ganges (Rajar Kaushik, 2015, Pieria Resource Library).Here author throws light on the dying conditions of the holy river Gangs which is highly polluted. It has been closely observed by the author that the cities like Kanpur, Varanasi, and Allahabad are polluted [5] these cities release the untreated waste, sewage, toxic chemical substances from Industries which in tum lead to pollution of the river Ganga. The author also talks about the self-purification of water, as the river moves forward with the distance it gets purified on its own. This has been clearly explained in the paper with the help of numerous examples. The Fig.1. Shows the polluted Kanpur-Varanasi sketch of river Ganga which is unfit for utility.

To get a clear picture the author formulates a dynamic problem as an example of mathematical model. The following are the governing equations:

From mass conservation equation,

$$\Delta S_t = \left\{ M + FC - F\frac{(s_0 - s_t)}{2V} \right\}$$

$$S_t = \frac{Mt + v_1 A_1 C - \frac{s_0}{2V} v_2 A_2}{\frac{1}{t} + \frac{v_2 A_2}{2V}}$$

If velocity flow rate at the initial and the end point of the stretch is same.

$$v_1 = v_2 = v$$

$$S_t = \frac{M + v\left(A_1 C - \frac{S_0}{2V} A_2\right)}{\frac{1}{t} + \frac{\nabla_2 A_2}{2V}}$$

S_0 be the initial time quantity of inctasuial waste, sewage in polluted stretch,

S_t be the quantity of industrial waste, sewage increase after’s’ days,

$S_t - S_0 = \Delta S_t$ be the total increment of industial wastersewage after't' days,

M be the amount of imtreated sewage, industrial waste releasing in the most polhted suetch per day,

F be the daily fow of river,

C be the concentration of pollutants in the water entering the most polluted stretch,

CF be the total sewage, industrial waste, pollutants entering the polluted stretch,

$\frac{s_0}{y}$ be initial concentration of pollutant water in the stretch if total volume of water in stretch is

V.
$\frac{s_t}{v}$ be concentration affer ' t ' deys,
During period of t' days we can assume that concentration of river in polluted stretch remains as $\frac{(S_3-S_e)}{2Y}$
The author shows mathematically that if sewage treatment is increased, the pollution decreases. Also author suggests to ban the daily release of pollutants.
i.e., $M \rightarrow 0$, from the abore equations we get,

$$(S_t - S_0)\left(1 + \frac{Ft}{2W}\right) = FCt - \frac{FS_0}{2W} ta_{15}\mathrm{M} \rightarrow 0$$

$\frac{S_0}{V} = C_0 =$ Initial concentration of sewageindustrial waste of polluted suetch

$$(S_t - S_0) = \frac{F(C - C_0)t}{\left\{1 + \frac{Ft}{2r}\right\}}$$

As the author considered Kanpur - Varanasi stretch as the most polluted part of river, therefore $C - C_0 < 0$ or $C < C_0$, therefore $S_t - S_0 < 0$ or $S_t < S_0$
This concludes that the river will recover from pollution. If equilibrium state is obtained then $S_t - S_0 = 0$, in 6. $C = C_0$ (Affer a sufficient time)
From the abore analysis, it is concluded that if the industries and populated cities continue to release the waste, harmful pollutants in the river, the pollution will increase and self-purification will not be effective. Mathematically the author shows that if sewage is boned or treated the pollution decreases.
The polluted Wastewater being discharged in the rivers which contain dissolved oxygen (DO), bacteria, nutrients, PH, toxic which is worsening the physical, chemical and biological properties of water [7] This is affecting the water quality, a background of water quality is been provided external inputs such as rainfall, wind solar radiation which determine the water quality annually. On the other hand, the water quality is also affected by the addition of waste, harmful substances by man. The concentration of these substances is determined by the dispersion and advection chancteristics of the water body.
It has been observed that any natural water body can be seen as a mathematical system, which consists numerous complex interacting systems, here the basic concept of mathematical modelling of one-dimensional habitat is used. A one-dimensional method is used since the rivers are longer rather than wide α deep and only longitudinal variations of constituent concentrations are resolved in the form of cross-section.
The general mass conservation equation is averaged owner the cross section of the strenm giving, for constituent's subjects to a single first-order decay-process,

$$\frac{\partial c}{\partial t} = -u\frac{\partial c}{\partial x} + \frac{d}{\partial x}\left[(D_x + D_L)\frac{\partial c}{\partial x}\right] - KC + \Sigma I$$

$x =$ Longitutinal distance along river, L
$D_L =$ longirudind dispersion coefficient, L^2/T
To determine the coefficient, the following formic can be discussed,

$$D_1 = 0.011\frac{\mathrm{u}^2\mathrm{n}^2}{\mathrm{Hu}}$$

DL is the longitudinal dispersion coefficient, L^2/T u is the Cross- section-averaged velocity, LT

B is the Strean width, L

H is the suream depth. L

w* = shear velocity,

Further, the authors formulate the analytical solutions of distribution of concentration of pollutants which predicts the changes in water quality in the rivers. Also, calculates the continuous discharge in the river.

The paper describes water pollution related problems using the one-dimensional method which concentrates only on the longitudinal vibrational to resolve in the form of cross-section-averaged values. While, for continuous discharge in the river, it is been concluded that dispersion can be neglected. Also with the prompt release of a component at a point in the stream the maximum concentration decreases with time to decay and dispersion. The depletion of dissolved oxygen in a water body caused by the discharge of pollutants with the help of a nonlinear mathematical model. Here, the problem is modelled by using several nonlinear processes which inches organic pollutants, bacteria, protozoa, dissolved oxygen and a biological species totally dependent on it. It is a well-known fact that, when the pollutants are discharged in the water bodies, it endangers the life of the biological species surviving in such a habitat. Further, the effect of the diminished level of dissolved oxygen on the survival of biological species in such an aquatic system is studied.

Authors consider a food chain type system in a water body containing pollutants, bacteria, protozoon, and a biological population whose growth rate is entirely dependent on the concentration of dissolved oxygen [8] the system is govemed by the following differential equations:

$$\frac{dT}{dt} = Q - a_1 T - \frac{K_1 TB}{K_{12} + K_{11} T}$$

$$\frac{dB}{dt} = \frac{\lambda_1 K_1 TB}{K_{12} + K_{11} T} - a_1 B - \lambda_{10} B^2 - \frac{K_1 BP}{K_{21} + K_{22} B}$$

$$\frac{dP}{dt} = \frac{\lambda_2 K_2 RP}{K_{21} + K_{22} B} - a_1 P - \lambda_2 P^2$$

$$\frac{dC}{dt} = q - a_2 C - \frac{\lambda_{12} K_1 RP}{K_{12} + K_{11} T} - \frac{\lambda_{21} K_2 BP}{K_{21} + K_{22} B} - \lambda_{11} a_1 B - \lambda_{21} a_2 P - X$$

$$\frac{dF}{dt} = \lambda_1 K_2 CF - a_4 F - \lambda_{16} F^2$$

Where$T(0) > 0, B(0) > 0, P(0) > 0, C(0) > 0, F(0) > 0$.

Here the a_1 depletion rate coefficients K_1 are proportionality constants, nhich are positive. It is seen that for the feasiblity of the model, the growth rate of bacteria and protozoa should be positive.

Hence, $\lambda_1 K_1 - K_{11} \alpha_1 > 0$ and $\lambda_2 K_2 - K_{22} \alpha_2 > 0$

Let T be the camalative concentration of organic pollutants B be the density of bacteria,

P be the density of protozoa.

C be the concentration of dissolved oxygen (DO).

F be the density of a biological population, Q be the cumulative rate of discharge of organic pollutants into the water body,

T the rate of depletion of cumulative pollutants concentration caused by natural factors is assumed to be proportional to its concentration. A non-linear model is studies and analyzed by the authors for the survival of biological species in presence of the pollutants, bacteria, protozoa, dissolved oxygen. An assumption is made that oxygen is depleted by several nonlinear biochemical and biodegradation processes. As per the analysis in this paper, when the rage of discharge of pollutants increases, the equilibrium concentration of dissolved oxygen decreases.

Owing to this the amount of biological population also decreases as it is completed dependent on it. It can be concluded that if the amount of discharge of pollutants is very high the equilibrium concentration of dissolved oxygen becomes negligible, which make the water unsuitable for survival of biological species.

Acid accumulates through both dry and wet depositions, these deposited particles get washed from these surfaces by rain and eventually get back to water bodies. Acid lowers the pH level in water bodies and for the survival of aquatic life an optimum pH level is required when acid lowers the pH lervel, the toxicity of metals mcreases. Owing these fictors, authors proposed a mathematical model using system of non-linear differentials equations with four state variable. The dependent variables resources, density of fish population and concentration of resources, density of a propagation and condensation of acid present in water [9] The mathematical formulation is as shown below,

$$\frac{dS}{dt} = S_0 - aS - gSP - a(T_1 + qC_n) + kcP + kbF + k_1F^2$$
$$\frac{dP}{dt} - gSP - cP - fFP$$
$$\frac{dF}{dt} - fPF - bF - kF^2$$
$$\frac{d(T_1 + qC_m)}{dt} = Q_0 - a(T_1 + qC_m) - a_1(T_1 + qC_m)S$$

With the initial condition:

$$S(0) = S_{10} > 0, P(0) = P_{10} > 0, F(0) = F_{10} > 0, T(0) - T_{10} > 0$$

It is concluded that the amount of toxic substances present in the nutrient pool increases the equilibrium level of resource and fish populations. When there is instability of non-living equilibrium and fish extinct the interior equilibrium exists. With the numerical example, using the set of parameters, authors calculated the interior equilibrium points for all the four state variables. Based on observation, even in the numerical simulation, the variables have reached the equilibrium points.

4. RESULT ANALYSIS

Water pollution and its consequences for aquatic animals are the major topics of this paper's review. Water contamination is discussed using a mathematical model. as well as the impacts of pollution on aquatic species and alterations in drastically declining oxygen levels and water quality. A flat person Pollutants are disposed of using a method in a river. These numerical simulations have been demonstrated to eliminate the pollution issue. The model has been created. Equations for nonlinear ordinary differential equations As an alternative, lowering the release of household sewage and artificial waste and protecting the protection of living things from hazardous contaminants. Benefits: Mathematical models can help to simplify difficult situations. The use of mathematical models allows us to make predictions. Using mathematical modelling, we may determine a greater understanding of the issue in the current world. The drawbacks of a mathematical model include a simplification of a real-world issue that excludes the model may include all of the problem's parameters [10] and work only under specific circumstances.

5. CONCLUSION AND FUTURE WORK

There are still a number of equally significant instances that are being precisely modelled because the circumstances allow for enough complexity. Modeling is one approach used to address issues with surface water contamination. Various changes that occur in lake water and related changes in water quality. Such predicting water quality, a model may be used to account for changes that have an impact on water. Determinants of excellence or variations in their intensity. Environmental assessment accuracy Understanding environmental processes is a prerequisite for employing models. And on selecting the right mathematical formulae to explain them. As opposed to that, Depending on the data sets that are accessible, namely the findings of the evaluation of the water quality indicators, which serve as the foundation for the estimate of the model's parameters and coefficients, In a In recent years, the use of computer simulation techniques in scientific research has increased. Especially with regard to studies on the state of the aquatic environment, Methods of computer analysis have emerged as a separate field of study, which significantly boosts the current eco-engineers' research capacity. During the past 30 years, mathematical modelling of water has advanced quickly. The quality of the resources has been seen. Many computer models have been created, which many nations, including Poland, effectively put into practice. This research provides a summary of the mathematical methods used to evaluate the water quality in dam reservoirs The mathematical model, which relied on advection diffusion equations for the concentrations of the pollutant and dissolved oxygen, has been widely used to forecast river water quality and to give trustworthy tools for managing its quality in impacted regions. In the physical research regions, this model is used to mimic the geographical and temporal distributions of several factors linked to water quality. The decision-supporting tools for water resource management are improved by the application of mathematical models in the simulations. Numerous aspects of water quality, including dissolved oxygen level, water velocity, pollutant addition, and saturation oxygen concentration, must be measured and employed in the model. It has been shown that river purity increases with increased diffusion and reaeration coefficients.

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