Original Research Paper

Volume - 11 | Issue - 08 | August - 2021 | PRINT ISSN No. 2249 - 555X | DOI : 10.36106/ijar

Mathematics

SOME MODELS FOR WATER QUALITY MANAGEMENT

Santosh Kumar Singh Bhadauriya* Pt.J.L.N.College Banda. *Corresponding Author

Neelam Singh Bundelkhand College Jhansi.

ABSTRACT Model is a purposeful representation of reality. Mathematical model is a translation of a real life problem in the world into a mathematical description. Mathematical modeling is a technique of translating real problems into mathematical problems, solving the mathematical problems and interpreting these solutions. Sometimes it is not possible to solve the mathematical problem. Then it is necessary to idealize or simplify the problem or approximate it by another problem which is close to original problem and it can be solved mathematically. Formulation of mathematical model contains three main steps: starting the problem, identifying the relevant factors and last is mathematical description.

KEYWORDS : Model, management, quality, programming, BOD and DOD

INTRODUCTION:

Pollution control models can be developed for pollution control of rivers, oceans, reservoir, ponds and lakes. Sometimes large amounts of waste products are dumped into these water sources. In India Rivers are the main source of drinking water, but we all know that water of rivers is not directly drinkable in most places. Thus there is a need for improvement. This paper deals with mathematical models for controlling water pollution in water sources especially for rivers. In order to preserve aquatic life, it is important to have minimum levels of BOD and DOD. It is also important that temperature of water is kept at reasonable levels for aquatic life. Water pollution control problem is not only a mathematical

In this article we consider water flowing in a river, waste water from industries and sewage systems is being added to river at m points denoted by i=1,2,3,………,m. Water is taken from river for drinking and other purposes at n points denoted by j=1,2,3,4,………n. The quality of water is measured by biochemical oxygen demand (BOD) or dissolved oxygen defect (DOD) deteriorates and is desired to decrease the effluxes of waste water at various points so as to bring minimal improvements in quality of water at the n intake points. By treating the waste water with chemicals in plants this can be done. But this process needs money. The optimization problem arises because we want to minimize the total cost of treatment at m sources subject to obtaining the desired improvements in quality of water at n points. To solve the optimization problems, the techniques of linear, nonlinear, integer and dynamic programming are required.

Linear Programming and Nonlinear water quality management model-

Let y_i be the quantity of waste water removed or cleaned at source i, $f_i(fi)$ be the cost of removing this amount of water, u_i be the upper bound of waste water that can be removed or cleaned at source i, $Q_{ji}(y_i)$ be the improvement in the quality of water at the point j due to removal of waste water y_i at the point i; c_j be the minimum improvement desired at the point j.

Then our optimization problem is,

$$Min\, z = \sum_{i=1}^{m} f_i(y_i) \ldots \qquad \ldots\ \ldots\ \ldots (1)$$

Subject to $\sum_{i=1}^{m} Q_{ji}(y_i) \geq c_j$; ($j$=1,2,3,………$n$)……………(2)

$0 \leq y_i \leq u_i$; (i=1,2,3,……m)……………………………………..(3)

Here **y_i;i=1,2,3,…….m** are the decision variables and the functions f_i and Q_{ji} are supposed to be known. The problem as formulated in (1)-(3) is a nonlinear programming problem. So this is nonlinear water quality management model. If f_i and Q_{ji} are linear functions, the problem becomes a linear programming problem and model becomes linear water quality management model.

Equity water quality management model-

In this model, it is necessary that each source remove same fraction L of its wastes, and we want to minimize z subject to achieving the desired improvement in quality of water at the m points. If a source already removing more than a fraction L of its waste water, it does not have to remove more, but if it removing less than L, it has to make up the deficiency. Thus, when M_i is the fraction being removed at present, it need not remove any additional fraction if $L<M_i$; it has to remove the additional fraction $L-M_i$ if $L>M_i$. Thus model is

$$Min\, z = \sum_{i=1}^{m} f_i(y_i) \ldots \qquad \ldots\ldots (4)$$

Subject to

$\sum_{i=1}^{m} Q_{ji}(y_i) \geq C_j$;($j$=1,2,3,………$n$)…………………(5)

$M_i + \frac{y_i}{u_i} = L$ if $L>M_i$(i=1,2,3,…….m) … ……………………..(6)

y_i=0 if $L \leq M_i$ (i=1,2,3,…….m)……………………………..(7)

$0 \leq \frac{yi}{u_i} \leq 1-M_i$ (i=1,2,3,…….m)……………………………..(8)

The cost of treating waste water is $\phi(L) = \sum_{i=1}^{m} f_i(yi) = \sum_{i=1}^{\prime m} f_i[(L-M_i)u_i]$,……..(9)

Where $\sum'$ denotes summation over only those sources for which $L>M_i$.

Modified Water quality management model -This models differs from equity model in sense that we do not have to remove same fraction L from each source. We divide whole river region into a number of parts and we need to remove fraction $L_1, L_2, L_3, \ldots, L_K$ from these regions.

Model is

$$Min\, z = \sum_{i=1}^{m} f_i(y_i) \qquad \ldots\ldots (10)$$

Subject to

$\sum_{i=1}^{m} Q_{ji}(y_i) \geq c_j$; ($j$=1,2,3,………$n$)…………………(11)

$M_i + \frac{y_i}{u_i} = L_k$ if $L_k>M_i$ (k=1,2,3,…….K)……………………(12)

y_i=0 if $L_k \leq M_i$ (i lies in the k-th region)………………(13)

If K=1, then this model becomes equity model and if K=m, we get linear Programming and nonlinear water quality management model.

The cost of treating waste water is

$$\phi(L_1, L_2, L_3, \ldots, L_K) = \sum_{k=1}^{\prime K} f_i[(L_k-M_i)u_i] (i=1,2,3,\ldots m) \ldots\ldots (14)$$

Where $\sum_k' denotes$ summation over only those sources in the k-th region for which for which $L_k > M_i$. The cost depends upon L_k ;k=1, the quality of water. It may be biochemical oxygen demand (BOD) or dissolved oxygen defect (DOD), but it is not as satisfactory as using a number of parameters to denote the quality of water. These models a2,3,…..,K and we choose these in such a way that cost is minimal subject to constraints.

But above models have limitations. Only one parameter is used to denotere static and water quality is considered only at discrete set of points.

REFERENCES:

1. Kapur. J,N,. Mathematical Models in Biology and Medicine, EWP Delhi,1992 .pp 500-505
2. Singh Bhupendra & Agarwal Neenu, Bio Mathematics.KPM Ltd Meerut,2011, pp 2
3. Some Mathematical models in Biosciences I, Mathematical Sciences Trust Society, 1990, New Delhi
4. K.E.F.Watt, Ecology and Resource Management, McGraw Hill, 1968, New York