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A Review on Ground Water Pollution – An Environmental Concern

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Abstract:- The number one environmental concern around the world is water pollution. The limited fresh water availability and increase of the population over the globe, as a result increases the generation of waste water being discharged to land, river, lakes and sea. Thereby polluting the fresh water available in streams, ponds, ocean, water bodies and ground water. The water adulteration condition in India is also in equally desperate position with great hazard to human health, aquatic life, vegetation and ecological balance. Hence water pollution issues are continuously becoming worse on a time scale. This review paper intended to bring awareness about an environmental concern in the field of water pollution and provides an insight on river pollution district effects on human health. And also further derive analytical solutions and numerical simulations have been carried out to justify the estimation of water pollution using mathematical modelling.

Keywords:- *Water Pollution, Surface Water & Groundwater Pollution, Harmful Chemicals, Infectious Diseases.*

I. INTRODUCTION

The Water pollution is one of the national and global issues around the world. In our whole planet, less than one third conquered by the land and remaining two thirds of earth surface is occupied by water. As world's population stays to grow, people are placing ever- growing anxiety on the earth surface and underground water resources. In a sense our oceans, lakes, rivers and underground water are actually "squeezed" by human being behaviours so that quality is decreased. So Water pollution emerges as a severe problem in the world, as virtually 70 % of its surface water supplies & rising percentage of its groundwater reserves are polluted by biological, toxic, organic, and inorganic contaminants as shown in fig. 1. In several cases, these sources have remained condensed hazardous for human being utilization, also for other actions such as agricultural & industrialized requirements. This shows that, we have to understand the difficulty of water adulteration in two foremost water systems: groundwater, surface water systems. Both systems are significant to us, because we depend on both systems which supplies drinking water for human beings, domestic animals and for other practices such as agriculture and industrial practice. In addition to human requirements, good condition of surfacewater is essential to provision healthy wildlife societies that depend on rivers, ponds, wetlands, lakes, sea for habitat and food. Surface water is a water, which present on the earth surface such as ponds, streams, lakes and wetland. This surface water is largely used for drinking, agricultural & industrial purposes. In other hand underground water is a part of water cycle. In precipitation stage, water drops on surface of earth which seeps down through soil, rocks so on, reaches to water table. Groundwater is largely used for agricultural purpose also it plays crucial role to recharge the rivers, ponds, wetlands, lakes. Therefore, surface water & groundwater systems equally important to us.

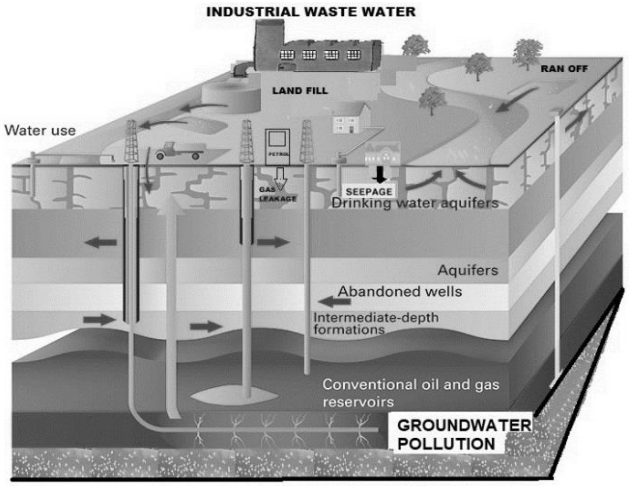

Fig 1:- Pictorial representation of Ground Water Pollution.

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II. REVIEW OF LITERATURE

90 percent of peoples says quality of water is foremost environmental concern. According to an investigation, more peoples are very much worried about quality of water supplies and their drinking water rather than other environmental problem fronting in the globe. In history, peoples in the planet, viewed at water contamination as a challenge pretending peoples far away. Most of the peoples sensed that world had hygienic, uncontaminated water. However, during 1970s & 1980s, the citizens noticed that a few places of world, water sources were contaminated. In some regions, the water was hazardous to drink because of high in nitrate, pesticide and bacterial intensities. Contamination of water deliveries was approaching, not only from towns, cities and industrial productions, but also from domestic animals and field overflow as well. Not only complications arising with water on surface, but problems arise in deep below the surface i.e. ground water. M. Dinesh Kumar and Tushaar Shah explained about Contamination and Groundwater Pollution in India. Their attempts to measure the nature and coverage contamination of groundwater in India which includes survey of contamination and their impacts. They also identify the challenges involved in groundwater pollution. Also they discussed about emerging preventive measures [1]. Quy-Toan Do, Shareen Joshi and Samuel Stolper studied about pollution externalities of Indian streams. In this study their attempts to explain about how domestic contamination on rivers, affecting human life and their health [2]. Rohitashw Kumar and Harender Raj discussed about harm and vindication of contamination in ground water. They explained about how chemicals are released into water can cause harmful health effects. They also provided remedial measures to control pollution like solid actions for safely manage the toxic chemicals, recycling and the practice of biodegradable products [3]. R.V. Waghmare and S.B. Kiwne provided mathematical modelling of disposal of pollutant into rivers. They also provide a solution for time dependent source, instantaneous source and continuous discharge [4]. Praveen Kumar M., Shobankumar, Dattatreya Hegde, S R.Sudheendra solved the effect of water content on solute transport in saturated and unsaturated porous media by analytical method [5]. G. Tsakiris and D. Alexakis presented in brief about utmost popular water quality models for streams and rivers which are presently available. Also purpose of the paper is to measure the capacities of these models for addressing the needs of water framework directive [6]. Hanani Johari, Nursalasawati Rusliand Zainab Yahya studied about water contamination of concentration transport through the numerical simulation methods [7].

III. MATERIALS & METHODS

A. Groundwater pollution and contamination in India: the emerging challenge (M. Dinesh Kumar, Tushaar Shah)-2006.

In this, authors studied the nature and extent of ground water contamination in India. The authors afford the challenge of tackling ground water contamination and pollution problems like technical issues, financial issues, institutional challenges in preventing pollution and contamination. Also institutional challenges in preventing pollution and contamination like demineralization technologies for cleaning ground water, low cost technologies for removing Arsenic from ground water, institutional challenges in implementing preventive measures, building technical and management skills available with water supply agencies strengthening civil society.

The authors showed in their results that, demineralization using RO systems can eliminate all forms of adulterations from drinking water. Also they have implemented the challenges in technological measures by water benefits in building technic and decision-making skill to design, install, operate, and manage sophisticated water healing organisms, by making human beings to pay for preserved water and to develop information and consciousness about threats to ground water quality.

B. Threat and Mitigation of Ground Water Contamination in India. (Rohitash w Kumar, Hardener Raj)-2018.

The Indian towns and cities are responsible for their wastewater discharge. Contamination by irrigational overflows has too major things on the nature. Purpose of insecticides is liable for harming. They are specifically challenging to take off from freshwater and hence they can be found in metropolitan or bottled water, even after conventional management. The latest survey drew the warning bell about the concentration in pesticides such as oregano-chlorines and organophosphates that was beyond the WHO standards in almost all the Indian varieties of bottled water. The fertilizers have an indirect contrary effect on water supplies. In spite of these well-known contrary effects, the perturbing growth of fertilizer and insecticide use in India agricultural sector, these products are still funded by the government. Even though, in many places of India we found that agriculturalist are using many kinds of insecticides, pesticides and other chemicals in order to get profit and crops early. Hence agricultural crops are becoming very much unsafe to consume due to high contamination.

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THREAT	SOURCES	HEALTH AND ECOSYSTEM EFFECT
Nitrates	Fertilizer runoff; fertilizer from domestic animals operations, septic systems	Suffocation and death in infants; digestive tract and other cancers. Algal blooms and eutrophication in surfacewater
Pesticides,	Runoff from farms, landfill leaks	Some linked to reproductive and endocrine disorders, nervous, system damage and cancers
Petro-Chemicals	Subversive petroleum storage tanks	Petrochemicals, Benzene and other chemicals can cause cancer even at low exposure.
Chlorinated solvents	Effluents from metals and plastics degreasing; fabric cleaning; electronics and aircraft manufacture	Linked to reproductive disorders and some cancers
Arsenic	Naturally occurring	Nervous system and liver damage; skin cancers
Radioactive materials	Nuclear testing and medical waste	Raised threat of certain cancers
Fluoride	Naturally occurring	Dental problems, crippling spinal and bone damage
Salts	Seawater intrusion	Freshwater unusable for drinking or irrigation

Table 1:- Major groundwater pollutants and their effect on human health and ecosystem.

Numerous chemicals that may be unconfined into water can cause contrary health effects that accompanying burden of disease can be substantial, venture in research on health effects, interventions in specific populations and acquaintance situations is important for the growth of control tactics. Pollution control is therefore an important constituent of disease control, and health professionals and consultants need to develop partnerships with other divisions to identify and contrivance priority interventions. Solid actions are required to securely accomplish the usage of poisonous chemicals and scrutinizing regulatory guidelines. Recycling and the usage of eco-friendly commodities must be encouraged.

C. Mathematical Modeling of Disposal of Pollutant in Rivers. (R.V. Waghmare, S.B. Kiwne)- 2017.

In this paper, by using advection diffusion equation in steady state, they found solutions for concentration of contaminant in a stream analytically. They also afford a solution for instantaneous source, time dependent source and continuous discharge.

➢ *One-Dimensional Modeling:*

The 1-dimensional modelling equation w.r.t single first order decay is given by

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

Where, x = L, longitudinal distance along river.

$$DL = \frac{L_2}{T}, \text{ longitudinal dispersion coefficient.}$$

This Equation is almost same to one of governing equations (i.e. mass conservation equation) without terms containing y and z derivatives, except for the existence of dispersion, which is distinctive and isolated from turbulent diffusion. Due to the correlation of cross-sectional velocity and concentration variations the dispersion term rises during the averaging process.

➢ *River Water Pollution, Advection-Diffusion Model:*

The advection-diffusion equation with concentration of contamination of river is given by

$$D\frac{d^2c}{dx^2} - u\frac{dc}{dx} - kc = 0$$

Here, D, u and k are correspondingly dispersion coefficient, velocity of river and decay rate of pollutants.

Further solving by taking conditions, steady state distribution can be determined for given values of source, velocity, and diffusion coefficient and decay rate. Concentration decreases with time due to decay and due to dispersion. With considering the condition that source, t is time dependent, then above equations becomes

$$\frac{\partial C}{\partial t} = D\frac{\partial^2 C}{\partial x^2} - u\frac{\partial C}{\partial t} - kC$$

To find solution for the equation, conditions are needed,

I.e. $C(x,0) = C_0$, $C(0,t) = C_s$ and $C(\pm\infty, t) = 0$.

The distribution of concentration of pollutants of analytical solution is derived as

$$C(x,t) = C_0 + \frac{(C_s - C_0)}{2}\left[erfc\left(\frac{x-ut}{\sqrt{4D}}\right) + \exp\left(-\frac{ux}{D}\right)erfc\left(\frac{x+ut}{\sqrt{4D}}\right)\right]$$

These solutions for steady state and transitory cases have been used expansively in the literature in predicting changes in the quality of water in the rivers. For more universal case of time dependent variations of the concentration in horizontal & vertical directions & also in 3-D distribution of the velocity field of stream waters for the use in concentration equation, the solving fluid flow Naiver-

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Stokes equation by applying numerical methods. Further they solved for instantaneous source, continuous discharge.

The 1-Dimensional technique, only longitudinal variations of constituent concentrations are determined in the form of cross-section averaged values. The universal mass conservation equation is averaged over the cross section of the stream giving, for component's subjects to a single first-order decay-process. In Instantaneous release of a component at a point in the stream is maximum.

D. An Analytical Solution of Effect of Water Content on Solute Transport in Saturated and Unsaturated Porous Media. (Praveen Kumar M., Shobankumar D M, Dattatreya Hegde, S. R. Sudheendra)-2015.

In this, authors found the differential equation solution in longitudinal direction that avoids this transformation, thus giving upsurge to an asymmetrical concentration distribution.

➢ *Temporally Dependent Dispersion Along Uniform Flow*

In this research paper author used equation is

$$\frac{\partial C}{\partial t} = \frac{\partial}{\partial x}\left(D(x,t)\frac{\partial C}{\partial x} - u(x,t)C \right)$$

where C is solute concentration at position.
x along the longitudinal direction at time *t*,
D is dispersion coefficient.

and u is the average velocity of fluid.
Using conditions,

$$D(x,t) = D_0 f(mt) \quad and \quad u(x,t) = u_0$$

Where m is a coefficient whose dimension is inverse of the time variable. Thus $f(mt)$ is an expression in non-dimensional variable (mt).The expression of $f(mt) = 1$ for $m = 0$ or $t = 0$. Further by taking saturated flow of fluid of concentration. The result of equation may be attained eagerly by use of Duhamel's theorem. If $C = F(x, y, z, t)$ is the diffusion equation solution for semi-infinite media where the original concentration is zero and its surface is preserved at concentration unity, then the solution of the problem is attained by estimating integration.

Differential equation for dispersion in flow through porous media provide upsurge to solution that is not symmetrical about $x = u_0 t$ for large values of η . Experimental evidence, however, divulges that D_0 is small. This specifies that, unless the region close to the source is measured, the concentration distribution is around symmetrical. Theoretically, $\frac{C}{C_0} \to \frac{1}{2}$ as $\eta \to 0$; conversely, only errors of the order of magnitude of experimental errors are presented in the ordinary experiments if a symmetrical solution is expected.

E. Water quality models: An overview (G. Tsakiris and D. Alexakis)-2012.

In this study, author recognise measures for contending the overexploitation of water sources in each phase state. The water models are anticipated to play a major role, not only for measuring quality of water and identifying trends in quality of water parameters, conversely for recognizing the influence on quality of water for the several possible alternative activities involved in the schedule of measures of each plan. Today several quality of water models occur and have been applied in many zones of the globe serving various resolutions. The purpose of this research paper is to provide a main popular quality of water models for streams and rivers which are currently accessible. And another purpose of this paper is to measure the capacity of quality of water models to addressing the requirements of WFD (water framework directive). Many different variety of quality of water model are available, in that following quality of water models are selected and explain about models briefly and discussed: The selected models are ECM (Export Coefficient Model), MIKE-11, MONERIS (MOdelling Nutrient Emissions in RIver Systems), DRAINMOD((hydrology prediction), SIMCAT (SIMulation of CATchments), TOMCAT (Temporal / Overall Model for CATchments), TOPCAT(Tool for OPerations on Catalogues And Tables)and QUAL2K(River and Stream Water Quality Model). Finally this paper recognizes the creation of the new generation quality of water models.

➢ *Export Coefficient Model (ECM)*

The modified model is given by equation:

$$L = \sum_{i=1}^{n} E_i \left[A_i (I_i) \right] + p$$

Where, L is the loss of nutrients.
E_i is the export coefficient for nutrient source i
A_i is the area in the river basin characterized by land use type i .
I_i is the input of nutrients to source i and p is input of nutrients from precipitation.

The procedure of Export Coefficient Model can be classified into 3 phases:

Phase-I: Three kinds of collection of data is showed.

First kind of data collection is by questionnaire assessment of all agriculturalists and land owners is conducted to inaugurate: (i) land management, (ii) land use, (iii) livestock numbers, (iv) livestock density, and (v) fertilizer applications to land by land use type.

Second kind of data collection: literature assessment is performed to inaugurate: (i) the environment and nutrient deletion efficiency of manure management, (ii) input of N

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and P to the catchment from atmospheric sources, (iii) human population to the catchments.

Third kind of data collection: field monitoring Programme is supervised to found: T-N & T-P water surface contents and annual lots transferred in the surface water surface.

Phase-II: Measurement of the legitimacy of the standardisation technique. If the general amount of accurateness for the authentication time does not exceed ± 10% of viewed nutrient loads, then the model can be accepted as valid. Comparison of model hind troupes with observed water quality for the time of responsiveness.

Phase-III: Use of the standardised model in the estimating step to measure the potential for enhancement of quality of water and to evaluate the range of potential management strategies.

The existing models are not fully apposite for fulfilling all the requirements elevated by the WFD. A new generation of water quality models is predictable to be planned in the coming years, mainly tailored to the contentment of the WFD requirements.

F. Finite Difference Formulation for Prediction of Water Pollution (Hanani Johari, Nursalasawati Rusli, and Zainab Yahya)-2018.

In this Investigation, they studied 1-dimensional advection-diffusion equation for forecasting the water contamination absorption transport. The numerical modelling is used, in order to evaluate the advection-diffusion equation, the implicit Crank Nicolson method is used.

➢ *Advection Diffusion Equation*

In paper, the mathematical formulation for advection diffusion equation will be accessible.

$$\frac{\partial c}{\partial t} + u\frac{\partial c}{\partial x} = D\frac{\partial^2 c}{\partial t^2}$$

Where, c is the concentration.
x is the position on the water.

t is the amount of time that passes.
D is the diffusion rate in x direction,
and u is the fluid velocity.

With an initial condition, $c(x,0) = f(x)$
And boundary conditions,

$$c(x,t) = g_0(x), \frac{\partial c}{\partial x}(l,t) = g_i \quad for \quad 0 \le x \le l$$

Further they used The FTCS (Forward-Time Central-Space) Techniques and The Crank Nicolson method to drawn a numerical solution then numerical solution is compared with the analytical solution and their result were conversed.

➢ *Numerical Simulation using Crank Nicolson Method*

By taking particular values for l and t, they draw a solution which is Crank Nicolson method is better than FTCS technique Hence, the Crank Nicolson method is used to evaluate the absorption of water contamination transport. By using advection-diffusion equation, which is fluctuating the 2 constraints D & u that denote the rate of diffusion and rate of velocity respectively. In this analysis, it reflected the specific one dimensional water contamination model problem as in Equation and shown a graph (figure 2) correspond to the rate of diffusion and rate of velocity respectively.

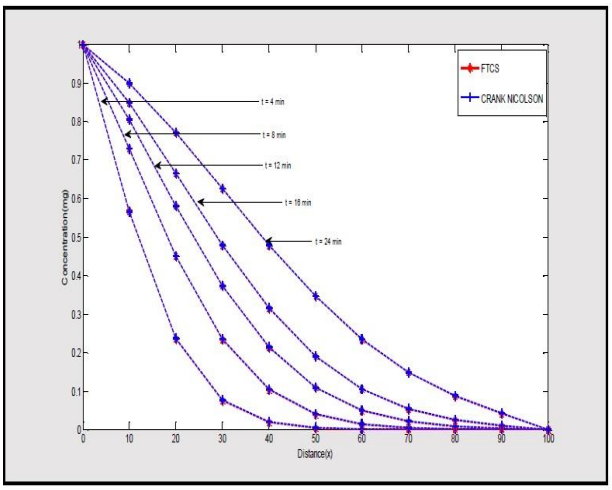

Fig 2:- Validation of concentration distribution profile at different time between FTCS and Crank Nicolson method.

Based on the results in Figure 2, the concentration contaminant transport is varying within the time. When the time increased, the further the distance of concentration contaminant moves and the quantity of water contaminant concentration decreased. The transport of water contamination concentration includes rate of velocity and diffusion. Hence, these two constraints are influenced to see the consequence towards the speed of the contaminant transport and concentration of contaminant travel at some distance. Similarly, author has done for consequence of water contaminant transport on rate of velocity and diffusion.

The estimation of the water contamination concentration transport has been studied through the numerical simulation. Based on the results, the implicit Crank Nicolson method is effectively used to solve the 1D ADE. This method is eminent for solving the ADE after fixing the error comparison with FTCS. It is effectively legalized with the FTCS method on the water pollution concentration distribution. Therefore, this implicit Crank Nicolson method can be deliberated as one of the approaches to solve one dimensional ADE specifically on water pollution problem.

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IV. CONCLUSION

In World, we all concerned about the quality of the ground water. Particularly, in 1987 the Indian administration passed the Groundwater Protection Act to preserve and improve the quality of water. However, there are still serious problems. Numerous studies performed all over the state indicate that groundwater supplies are still being contaminated with pesticides, nitrates and other chemicals. Surface water supplies remain to be contaminated by city and industrial treatment plants and through livestock and agricultural runoff and chemical leaks.

As we have seen, they are no easy solutions. There are trade-offs every step of the way. Reduced chemical control of weeds requires more mechanical control and more trips around the field which in turn uses more fuel for equipment. Animal wastes may be important to helps soil fertility and increases production but unnecessary measures may cause air and water pollution problems. In nearly all cases, there are both short-term and long-term benefits and potential problems.

This review mainly focusses on groundwater pollution for an environmental concern. As we observed, many researchers have studied and derived modelling about water pollution from many aspects. But, a common conclusion we can draw, that there is a still scope for the development and testing of detailed analytical and numerical model for contamination of groundwater.

The advantages of using mathematical models:

- Model signifies the real world problems/situations.
- Make simpler the large and complex situations.
- Ability to estimate system behaviour.
- Ability to investigate strange behaviour by comparing it to the model-predicted behaviour.

The disadvantages of using mathematical models:

- The model may eradicate main prognostic power by being too simple.
- The model may be efficient in selected situations, but not in all other situation.
- In all situations, the expected conditions may not be recognizable or understood by next users.

REFERENCES

[1]. M. Dinesh Kumar, Tushaar Shah(2006) Groundwater Pollution and Contamination in India. https://www.researchgate.net/publication/241760985.

[2]. Quy-Toan Do, Shareen Joshi, Samuel Stolper (2014), Pollution Externalities and Health: A Study of Indian Rivers.

[3]. Rohitashw Kumar, Harender Raj (2018), Threat and Mitigation of Ground Water Contamination in India. Acta Scientific Nutritional Health, Volume 2 Issue 8 August 2018.

[4]. R.V. Waghmare, S.B. Kiwne, (2017) Mathematical Modeling of Disposal of Pollutant in Rivers. International Journal of Computational and Applied Mathematics. ISSN 1819-4966 Volume12,Number 3 (2017), pp. 835-842 © Research India Publications.http://www.ripublication.com

[5]. Praveen Kumar M., Shobankumar D M, Dattatreya Hegde, S. R. Sudheendra (2015), An Analytical Solution of Effect of Water Content on Solute Transport in Saturated and Unsaturated Porous Media. International Journal of Engineering Research & Technology (IJERT), ISSN: 2278-0181, Published by, www.ijert.org,ICESMART-2015 Conference Proceedings.

[6]. G. Tsakiris and D. Alexakis, (2012) Water quality models: An overview, European Water 37: 33-46,2012.©2012 E.W.Publications.

[7]. Hanani Johari, Nursalasawati Rusli, and Zainab Yahya, (2018) Finite Difference Formulation for Prediction of Water Pollution, IOP Publishing: Materials Science and Engineering 318 (2018) 012005.