Impact of River Pollution on Ground Water Quality: A Review

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Abstract— Water is a chief requirement for all living being on the earth and it is natural occurring resources on the earth. In ancient time most of developed cities grow near basin of river, now this trend changing after development of road. River water was prime resource for these people. They were protecting the river from any types of pollution and these people aware from water pollution that raise problems for existence of life on the earth. After initiation of industrialization rapidly increase pollution into river water. The people using river water from long time, after river water contaminated suddenly moves on utilization of ground water. Now everyone are depends on ground water and fulfill their all needs. Surface water and ground water are connected with hydrological interaction and surface water pollution causes ground water pollution. Ground water contaminations will strongly impact the global water cycle. The qualitative analysis of most of river such as Ganga, Yamuna, Gomati and many other rivers shows deterioration in surface water quality.

Key words: Surface Water, Ground Water, Industrial Effluents, Physico-Chemical Characteristics

I. INTRODUCTION

Water is a basic need for humans and other living being, absence of water cannot consider any things about life. Most of developed and famous historical cities grow near bank of river because requirement of water for survive. Water pollution is rapidly moves to raise a question mark on existence of life. Human are totally depends on water for different type of activities. Due to globalization and industrialization increase the demand or requirement of water for their activities and further increase pollution of Surface water and ground water also. An approximately all water bodies are get polluted including Ground Water. Polluted water is easily mixed in water and destroys the original quality of water. Ground water resource plays a very vital role drinking water by hand pump or piped water supply system. Ground water resource widely consumed by Urban and Rural areas by use of different type of water supply system. Disposal of industrial effluents and domestic sewage in river causes a reduction in water quality. Due to disposal of effluents in river gradually deteriorate ground water. Ground Water pollution is irreversible once ground water polluted it is difficult to treat.

Ami River is a tributary river which originated from Rapti River at prehalla, Siddharthnagar and confluence to Rapti River at Sahagaura Kauriram. Ami River moves 126 Km serpentine length in three districts such as Siddharth Nagar, Sant Kabir Nagar and Gorakhpur. It receives the effluents from Gorakhpur Industrial Development Authority (GIDA), in which more than 200 hundred big and small industries are established. Ami River receives industrial and domestic effluent more than 3 decades and there are more than 200 villages and few towns that are exists in downstream of Ami River. The people of downstream locations are suffering from various bacteriological diseases. The most polluted effluents generating industries located in Rudhauri, Khalilabad, and Sahjanwa (GIDA). This pollution is damage the surface water and ground water of downstream locations of Ami River. There is several campaigns organized by peoples of these areas but apathy about river, the owner of industries are further continue to discharge the effluent into Ami River. Due to this over contamination poses completely absence of aquatic ecosystem.

II. LITERATURE REVIEW

K.P.Singh and H.K.Sharma (1999) were studies the ground water pollution due to industrial waste water and its control in Punjab state. They were studies the physic-chemical characteristics at different locations of Punjab state.

B.S.Sharma (1999) was studies the water quality of Yamuna River at Agra. He was observed physic-chemical characteristics of river water and detected the organic and chemical matters on river water.

N.K.Das and R.K.Sinha (1994) were studies the pollution status of Ganga River at Patna (Bihar). They were observed the physical characteristics of Ganga River and detected high pollution load on river.

Promad Kumar Vishacakarma (2010) was studies the water quality of Ami River and during 6-months at nine stations. He was detected that river receives high organic and chemical matter during sampling period.

Uday Bhan Prajapati and Anil K. Dwivedi (2011) were studies the impact of industrial waste on water quality of Ami River and observed the seasonal variation of water quality of Ami River. They were selected the five sampling station along length of river and statistical analysis of selected parameter were done.

Apoor Verma (2014) was studies the ground water pollution in urban and semi-urban areas of Gorakhpur city. He was observed the physic –chemical characteristics of ground water and detected that organic contamination.

Abhishek Kumar Bharti (2015) was studies the ground water quality of adjoining areas of Ramgarh Taal at Gorakhpur city. He was observed the physic-chemical of ground water during four months.

III. IMPACT OF RIVER POLLUTION ON GROUND WATER QUALITY

The river water carries the industrial and domestic effluent i.e. Multi fluid miscible. These drained effluents completely collide with water and reached at subsurface through infiltration.

A. Recharge Mechanism (Flow through Porous Media)

The saturation of soil occurred through steady and unsteady flow, which changes with function of time and entire pore space is not completely saturated with liquid flow. The
knowledge concern to such flow helps some employees like hydrologist, agriculturist, and many fields of science and engineering. The infiltration of water and underground disposal of seepage and waste water are encountered by nonlinear partial differential equations.

B. Mathematical Formulation of Problem

The equation continuity for the mixture is given by
\[
\frac{\partial \rho}{\partial t} + \nabla \cdot (\rho \vec{v}) = 0
\]

Where \( \rho \) is the density of mixture and \( \vec{v} \) is pore velocity. The equation of diffusion for fluid flow through homogenous porous medium with no addition or subtractive of dispersing material is given by,
\[
\frac{\partial c}{\partial t} + \nabla \cdot (c \vec{v}) = \nabla \cdot \left[ \rho \vec{D} \nabla \left( \frac{c}{\rho} \right) \right]
\]

Where \( c \) is the concentration of the fluid A in the other host fluid B (i.e. \( c \) is the mass of A per unit volume of the mixture), \( \vec{D} \) is the tensor co-efficient of dispersion with nine components \( D_{ij} \).

In a laminar flow through homogeneous porous medium at constant temperature, \( \rho \) may be considered to be constant. The equation (1) gives
\[
\vec{v} \cdot \vec{v} = 0
\]

And equation (2) becomes
\[
\frac{\partial c}{\partial t} + \nabla \cdot (c \vec{v}) = \nabla \cdot \left[ \rho \vec{D} \nabla \left( \frac{c}{\rho} \right) \right]
\]

When the seepage velocity \( \vec{v} \) is along the X-axis, the non-zero components are \( D_{11} = D_L \) and \( D_{22} = D_T \) (coefficient of transverse dispersion), and other \( D_{1j} \) are zero.

Thus equation (3), in this case, becomes,
\[
\frac{\partial c}{\partial t} + u \frac{\partial c}{\partial x} = D_L \frac{\partial^2 c}{\partial x^2}
\]

Where \( u \) is the component of velocity along X-axis which is time dependent and \( D_L \) is the longitudinal dispersion co-efficient. An appropriate initial and boundary conditions are,
\[
c(x,0) = y_0, 0 \leq x \leq L, c(0,t) = y_1 \text{ and } c(L,t) = y_2, t > 0 \quad (5)
\]

Where \( y_0 \) is the initial concentration of the tracer, \( y_1 \) is the concentration at \( x = 0 \) and \( y_2 \) is the concentration at \( x = L \).

Since \( u \) is the cross-sectional time dependent flow velocity through porous medium, it is regarded as \(-1/\sqrt{t}\) (where negative sign shows the decreasing of velocity in the direction of flow) for definiteness. Again by setting dimensionless variables, \( X = x / L \) the equation (4) together with (5) becomes
\[
\frac{\partial c}{\partial \tau} + \frac{1}{L^2 \sqrt{\tau}} \frac{\partial c}{\partial X} = D_L \frac{\partial^2 c}{\partial X^2}
\]

And \( c(X,0) = y_0, 0 \leq X \leq 1, c(0,\tau) = y_1 \text{ and } c(1,\tau) = y_2, \tau > 0 \quad (7)
\]

Now we use \( \alpha \) similarity (Boltzmann) transformation to convert equation (3.9.6) into an ordinary differential equation. For that we consider
\[
\eta = X^n t^{1/2} \quad (8)
\]

Where \( \alpha \) and \( \beta \) are to be determined so as the resulting equation in \( \eta \) will be free from \( X \) and \( t \). Substituting (8) in (6), we get
\[
\beta X^2 \frac{\partial \eta}{\partial \tau} + X \frac{\partial \eta}{\partial X} = \frac{D_L}{L^2} \left[ \alpha (\alpha - 1) \eta \eta' + \alpha^2 \eta^2 \eta'' \right]
\]

Now the right hand side of equation (3.9.9) is the free of \( X \) and \( t \), thus for the full equation to be a function only of \( \eta \) That is \( X^2 / t = f(\eta) \) Which determines the values of \( \alpha \) and \( \beta \).

Here we choose \( f(\eta) = \eta^2 \); so that \( \alpha = 1 \) and \( \beta = -1/2 \). The transformation (8) is called the Boltzmann transformation, and under equation (6) becomes,
\[
D_L \frac{\partial^2 c}{\partial \eta^2} + \frac{L^2}{2} \eta \frac{\partial c}{\partial \eta} = 0, D_L \neq 0 \quad (10)
\]

Under the transformation (8), the first boundary condition becomes (since \( \tau > 0 \))
\[
c(0) = \gamma_1 \quad (11)
\]

And the initial and second auxiliary conditions are consolidate only if
\[
\gamma_0 = \gamma_2
\]

And hence we have
\[
c(1) = \gamma_2, c(L) = \gamma_2 \quad (12)
\]

C. Mathematical Solution of Problem

Using series solution for equation (10)
\[
c = \sum_0^\infty a_k \eta^k \quad , a_0 \neq 0 \quad (13)
\]

Substituting (13) in (10), we get
\[
2a_2 D_L + L a_1 = 0 \Rightarrow a_2 = -\frac{L a_1}{2 D_L} \quad (14)
\]

\[
a_k = -\frac{L}{D_L} a_{k-1} - \frac{L^2}{2 D_L} a_{k-2}, k \geq 3 \quad (15)
\]

\[
k = 3, a_3 = -\frac{L^2}{60 D_L} \frac{1}{L^2} + \frac{1}{2} a_1 \quad (16)
\]

\[
k = 4, a_4 = -\frac{L^2}{240 D_L} \frac{1}{L^4} + \frac{3}{4} a_1 \quad (17)
\]

Substituting (14), (15) and (16) in (13) we get
\[
\sum_0^\infty \left[ \frac{D_L}{L^2} \eta^2 + \frac{2 D_L}{L^2} \eta + \frac{D_L}{L^2} \eta^2 \right] a_k \eta^{k-2} = 0 \quad (18)
\]

\[
c(0) = \gamma_1 \Rightarrow a_0 = \gamma_1, c(1) = \gamma_2 \Rightarrow a_1 = \frac{2\gamma_2 - \gamma_1}{\gamma_1} \quad (19)
\]

From equation (18), we get
\[
\sum_0^\infty \left[ \frac{D_L}{L^2} \frac{1}{L^2} + \frac{2 D_L}{L^2} \frac{1}{L^4} + \frac{D_L}{L^2} \frac{1}{L^6} \right] a_k \eta^{k-2} = 0 \quad (20)
\]

\[
\left[ c = \frac{\gamma_2 - \gamma_1}{\gamma_1} \sum_0^\infty \left[ \frac{D_L}{L^2} \frac{1}{L^2} + \frac{2 D_L}{L^2} \frac{1}{L^4} + \frac{D_L}{L^2} \frac{1}{L^6} \right] a_k \eta^{k-2} \right] \quad (21)
\]
D. River Bank Filtration

Bank filtration is infiltration process of surface water (mostly river system) to ground water. It is tempted by water abstraction nearby to surface water i.e. river bank. This system is improved by operating water well, in which water abstract through soil pores, it is filtered and quality of water is improved (Sharma and Amy 2009).

Bank filtration has been practiced in many European cities for more than 100 years. It is process used for removing suspended organic matter and bacteriological pollution, which comes from released contaminated effluent into river (SCHMIDT et al. 2003).

Bank filtration potentially reduces the organic matter, microbial, and particulates load. It is make drinking water more safe and acceptable for people. But not remove all undesirable matter during soil and aquifer passes (SCHMIDT et al. 2003, HUELSHOFF et al. 2009).

![Bank Filtration Diagram](image)

Fig. 1: Bank filtration

In bank filtration, abstraction of ground water from aquifer, it is hydraulically connected to surface water. The abstraction of ground water by pumping of well, adjoining to catchment of surface water body, the ground water table is lowered and water from surface water body infiltrate to aquifer (HISCOCK and GRISCHEK 2002).

E. Impacts on Water Quality

The naturally recharge of ground water phenomenon resulting recharge arrangements and mineral dissolution can be highly modified by a varied range of contamination may be indicated as different phases within the subsurface Conant (2000) concise the factors that may analyses the impact of a contamination present in the subsurface on a surface water bodies. They includes-

1) Physical and chemical characteristics of contamination
2) Geometry and temporal variations in contamination source
3) Transport mechanism
4) Reactions (reversible and non-reversible)

The physical and chemical properties of contaminates stability and toxic effect. The toxic compound may move readily reached and mixed with ground water that causes high level of concentration.

The ground water contamination is categorized in forms such as point source and non-point source (Rivett, 2000). The point source are waste dump, industrial waste injection and industrial spill and non-point sources are the application of fertilizer and pesticides for agricultural uses which discharge in surface water and reach into ground water. Surface water quality largely varied with climatic change and anthropogenic activities like precipitation, soil erosion, municipal discharge etc. The season variation in precipitation, surface runoff and other weathering effects are disturb the surface water quality and also possible change in ground water.

IV. REMEDIAL MEASURES

Ground water remediation is the process that uses for remove the harmful pollutants from ground water. There are various techniques are available for removal of pollutants.

A. Remediation Technique

1) Physical Treatments
   - Pump and Treat
   - Air Sparging
   - Dual phase vacuum extraction
   - Monitoring- Well Oil Skimming

2) Chemical Treatments
   - Chemical Precipitation
   - Ion Exchange
   - Carbon Absorption
   - Chemical Oxidation
   - Surfactant Enhanced Recovery
   - Permeable Reactive Barriers

3) Biological Treatments
   - Bioaugmentation
   - Bioventing
   - Biosparging
   - Bioslurping
   - Phytoremediation
   - Permeable Reactive Barriers

V. CONCLUSION

The discussion to this point is very poor condition of water quality of Ami River. Over contamination is continuously degrading the water quality of river. The initial is deterioration starting at Khalilabad and complete deterioration at Adilapar and whole length is not recovering self-purification capacity. Over contamination of Ami River is alarming the ground water pollution to government authority and citizen. There is need to understand the importance of water resource and how to industrial and domestic effluents discharge into surface water, impact to our ground water resource.

REFERENCES