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A COMPREHENSIVE REVIEW ON GROUND WATER

Arun Yadav.[1*], Abhijit Sonje.[1], Priyanka Mathur[2] Amrish Chandra.[3], Devanand Jain[4], Chandrakant Pardeshi[5]

1. Baxil Pharma Pvt Ltd, Nainital Highway, Shyampur, Dist-Haridwar 249 408 (India)
2. Aryabhat Collage of Education, Ajmer (India).
3. Departement of Pharmaceutics, Amity University, Noida 201 301 (India)
4. Institute of Pharmaceutical Sciences & Research Center, Bhagwant Univrsity, Ajmer (India)
5. R. C. Patel Institute of Pharmaceutical Education and Research, Shirpur 425 405 (India).

ABSTRACT

Water plays a vital role in human life .The total amount of water, below and on the surface of the earth has been estimated to be $1.33x10^{24}$ kg. Which is about 5% of the total mass of the earth .The consequences of urbanization and industrialization leads to spoil the water. For agriculture purposes, ground water is utilized in rural areas, especially in those areas where other sources of water like dam and river or a canal is not available. In India, most of the population is dependent on ground water supply. The ground water is believed to be comparatively much clean and free from pollution than surface water. Ground water is used for domestic and industrial water supply and irrigation all over the world .In the last few decades, it has been seen that there is a tremendous increase in the demand for fresh water due to rapid growth of population and accelerated pace of industrialization. Human health is threatened by most of the agricultural activities particularly in relation to excessive application of fertilizers, pesticides, irrigation practices and unsanitary conditions.

Keywords: Ground water, Industrialization, Agricultural, Pesticides.

*Corresponding Author Email: abhi.sonje4u@gmail.com

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INTRODUCTION[1, 14, 16, 17, 18]

The urbanization rate in India is very fast. It has increased from 10.84% in 1901 to 28.5 % in 2001. According to the census figure of 2001, the number of class I cities and class II towns was around 900. One of the conspicuous features of urbanization in India is the skewed distribution of population with as much as 28.3% of the urban population in 35 metropolitan cities. Unregulated growth of urban areas, particularly over the last two decades, without infrastructural services for proper collection, transportation, treatment and disposal of domestic waste water led to increased pollution and health hazards. Fast urbanization followed by increase in prosperity resulting in steep increase in waste generation.[1,]

The municipalities and other civic authorities are responsible for management of the waste but that have not been able to cope up with this massive task and could be attributed various reasons including erosion of authority, inability to raise revenues & inadequate managerial capabilities. That is why, it became necessary to launch the plan of survey which are essential addressed to the task of trapping, diversion and treatment of municipal waste water.

As per the latest estimate of Central Pollution Control Board, about 49,000 million liter/day of waste water generated from class-I cities and class-II towns out of which about 45% is generated from metro-cities alone. The collection system exists for only about 30% of the wastewater through sewer line and treatment capacity exists for about 7000 million liter/day.[1]

Thus, there is a large gap between generation, collection and treatment of wastewater. A large part of un-collected, un-treated wastewater finds it way to either nearby surface water body or accumulated in the city itself forming cesspools. In almost all urban centers ceespols exist. These ceespols are good breeding ground for mosquitoes and also source of groundwater pollution. The wastewater accumulated in these ceespols gets percolated in the ground and pollute the ground water. Also in many cities/towns conventional septic tanks and other low cost sanitation facilities exists. Due to nonexistence of proper maintenance these septic tank become major source of ground water pollution. In many urban areas ground water is the only source of drinking. Thus a large population is at risk of exposed water born diseases infectious (bacterial, Viral or animal) or chemical nature (arsenic or fluoride). Water born diseases are still great concern in India.

Pollutants are being added to the groundwater system through human activities and natural processes. Solid waste from industrial units is being dumped near the factories,

And subjected to reaction with percolating rainwater and reaches the groundwater level. The percolating water picks up a large amount of dissolved constituents and reaches the aquifer

system and contaminates the groundwater. The problem of groundwater pollution in several parts of the country has become so acute that unless urgent steps for abatement are taken, groundwater resources may be damaged.

The quality of groundwater depends on a large number of individual hydrological, Physical, Chemical and Biological factors. Generally higher proportions of dissolved constituents are found in groundwater than in surface water because of greater interaction of groundwater with various materials in geologic strata. The water used for drinking purpose should be free from any toxic elements, living and nonliving organism and excessive amount of minerals that may be hazardous to health. Some of the heavy metals are extremely essential to humans, for example, Cobalt, Copper, etc., but large quantities of them may cause physiological disorders. The contamination of groundwater by heavy metals has assumed great significance during recent years due to their toxicity and accumulative behavior. These elements, contrary to most pollutants, are not biodegradable and undergo a global eco-biological cycle in which natural waters are the main pathway. The determination of the concentration levels of heavy metals in these waters, as well as the elucidation of the chemical force in which they appear is a prime target in environmental research today. [1,16,17,18]

A vast majority of groundwater quality problems are caused by contamination, over exploitation, or combination of the two. Most groundwater quality problems are difficult to detect and hard to resolve. The solutions are usually very expensive, time consuming & not always effective. An alarming picture is beginning to emerge in many parts of our country. Groundwater quality is slowly but surely declining everywhere. Groundwater quality is intrinsically difficult to detect, since problem may well be concealed below the surface & monitoring is costly, time consuming & somewhat hit or miss by nature. Many times the contamination is not detected until obnoxious substances actually appear in water used by which time the pollution has often dispersed over a large area. Essentially all activities carried out on land have the potential to contaminate the groundwater, whether associated with urban, industrial or agricultural activities.

Large scale concentrated sources of pollution such as industrial discharges, landfills & subsurface injection of chemicals & hazardous wastes are an obvious source of groundwater pollution. These concentrated sources can be easily detected & regulated but the more difficult problem is associated with diffuse sources of pollution like leaching of agrochemicals & animal wastes, subsurface discharge from latrines & septic tanks & infiltration of polluted urban run-off

sewage where sewerage does not exists or defunct. Diffuse sources can affect entire aquifers which are difficult to control & treat.

The only solution to diffuse sources of pollution is to integrate land use with water management. Once pollution has entered the sub-surface environment, it may remain concealed for many years, becoming dispersed over wide areas & rendering groundwater supplies unsuitable for human uses.

Common Groundwater Contaminants- **(1, 7,8,9,10,12,15)**

1. Nitrates: Dissolved nitrate is most common contaminant in groundwater. High level can cause blue baby disease (Methamoglobinamia) in children, may form carcinogens & can accelerate eutrophication in surface waters. Sources of nitrates include sewage, fertilizers, air pollution, landfills & industries.
2. Pathogens: Bacteria & Viruses that cause water borne diseases such as typhoid, cholera, dysentery, polio and hepatitis. Sources include sewage, landfills, septic tanks & livestock's.
3. Trace Metals: Include Lead, Mercury, Cadmium, Copper, Chromium & Nickel. These metals can be toxic & carcinogenic. Sources include industrial & mine discharges, fly ash from thermal power plants either due to fallout or disposal in ash ponds. Industrial solid waste dumping and leaching into groundwater through rainwater.
4. Inorganic Constituents: Inorganic dissolved salts accumulation such as SO, Chloride etc along with Na, K building up high dissolved solids and combination of Carbonates, Bicarbonates along with Ca and Mg building up high concentration of hardness of water from sweet or soft water which causes G.I.T disorders after drinking it.
5. Organic Compounds- Includes Volatile semi compounds like petroleum derivatives & pesticides. Sources include Agricultural activities, street drainages, sewage landfills, industrial discharges, spills & vehicular emissions.

According to WHO organization, about 80% of all the diseases in human being are caused by water. Once the groundwater is contaminated, its quality cannot be restored by stopping the pollutants from the source. It may be assumed that natural water usually contain compounds such as$CaCO_3$,$CaCl_2$,$CaSO_4$,$MgSO_4$,NaCl , $Mg(HCO_3)$,$Ca(HCO_3)$ etc. In addition to these ,natural water also contain ammonium cation(NH_4) in small quantities .The presence of these compounds indicates that water basin is contaminated by industrial waste .In ground water iron ,usually occurs as ferrous bicarbonate which is stable only in presence of large amount of CO_2..

All natural water also contains gases of which CO_2, and O_2 causes corrosion .Dissolved gases such as O_2, CO2, H2S, etc may be present in water as impurities.

Fertilizers, pesticides , insecticides ,herbicides processing wastes and animal wastes etc are constantly added to the water ,which move downward with percolating water and join the aquifers below posing danger to the ground water. Presence of pesticide and coli form is akin to slow poisoning while heavy metals fluorine and iron may cause widespread digestive disorders, skin diseases and dental problem.

Prolonged discharge of industrial effluent, domestic sewage, and solid waste dump cause the ground water to become polluted and create health problem .Hence there is always a need for and concern over the protection and management of ground water quality. Around 62.5 million people are suffering from disorder of teeth or bones through fluorosis, which is due to consumption of fluoride rich water. Virtually almost all the ground water in India is unfit for direct consumption. In spite of the fact that the municipal water supply in most of the cities is through treated ground water, due to over contamination more stringent treatment would be required to make the ground water potable. The prominent source of ground water pollution is domestic sewage, industrial waste, and agriculture run off .So we must turn to our ground water .The application of fertilizer, pesticide, manure lime refuse dumps etc is the main source of bore well water pollution in many village.[10]

According to WHO organization, about 80% of all the diseases in human beings are caused by water. Once the ground water is contaminated its quality cannot be restored by stopping the pollutants from the source. Water quality index is one of the most effective tools to communicate information on the quality of water to concerned citizens and policy maker. It thus becomes an important parameter for the assessment and management of ground water.[13]

The environment and the human health are closely interrelated. The wellbeing of the people is the reflection of the healthy environment, but both can damage by pollution. Pollutants released into air, water and soil can find their way in to human body by breathing, eating and drinking. Growing urbanization, rapid industrialization without proper plan, excess use of chemical fertilizers, insecticides, and pesticides in agriculture field has deteriorated the quality of water, causing water pollution. In broad perspective “Pollution” means such contamination of water or such alteration of the physical, chemical or biological properties of water or such discharge of any sewage or trade effluent or of any other liquid, gaseous or solid substance into water (whether directly or indirectly) as may, or is likely to, create a nuisance or render such water

harmful or injurious to public health or safety, or to domestic, commercial, industrial, agricultural or other legitimate uses, or to the life and health of animals or plants or of aquatic organisms (Govt. of India, 1974). Pollution in water bodies can enter through one or more of the following ways:

1. Point Sources: Transfer of pollutants from municipal, industrial liquid waste disposal sites and from municipal and household hazardous waste and refuse disposal sites. The pollution from these sources can be measured directly or otherwise quantified and one can evaluated their impact directly.
2. Non-point Sources or Diffuse Sources: Wash off and soil erosion from agricultural lands carrying material applied during agricultural use, mainly fertilizers, herbicides and pesticides. Runoff from urban streets, commercial activities, industrial sites and storage areas and there is no single outlet of such source but consists of a number of outlets.

Change in the hydraulic regime of water system due to excessive water abstraction, construction of developmental works.

Broadly, the major sources of water pollution can be divided as urban and domestic waste, industrial waste, agricultural sources, mining wastes, induced contaminated source, radioactive substances etc. In municipal areas the solid waste is produced at a rate of 0.33 kg/capita/day and thus the production of solid waste by the urban population of the country is around 23 million tons per year. Therefore, urban and domestic wastes play a significant role in polluting the water. Industrial wastes discharge plays an important role in the deterioration of water quality specially in urban and industrial areas. Besides several environmental guidelines for industries in India, there is lack of facilities to treat the solid and liquid waste and the same is generally dumped in low lying/open area by these industrial units, which moves downwards to lower reaches causing pollution in ground water regime. To increase the yield, indiscriminate use of fertilizers has also resulted into higher concentration of some constituents like Nitrates and Phosphate. Pollution is therefore considered as a major threat at the system level involving environmental implications and needs to make efforts for its control and remediation.

Various pollutants present in water are measured through water quality parameters and can be broadly classified into following categories:

Physical parameters: appearance, temperature, turbidity, colour, taste, odour

Chemical parameters: all inorganic and organic substances (e.g. pH, acidity, alkalinity, hardness, conductivity, chlorides, sulphates, nitrates, nitrites, ammonia, fluoride, boron, heavy

metals, pesticides, detergents, phenols, cyanide, radioactivity, oil and greese, organics, BOD, COD, DO etc.[9]

Biological parameters: Total Coliform, MPN, Total plate count (TPC)

The water is being used as multipurpose resource in India. The main uses of water are public water supply, outdoor bathing & recreation, fisheries & wildlife propagation, irrigation & other agricultural uses, cooling in power plants, navigation and disposal of wastes. Most of these uses are often conflicting. In order for any water body to function adequately in satisfying any one of the above mentioned use, it must have corresponding degree of purity. In terms of quality, drinking water needs highest level of purity, whereas disposal of wastes can be done in any quality of water. Therefore there is great need to maintain the quality of water as it is as important as the quantity. [9]

Table 1. Designated Best Use Classification of Ground Water.

Designated Best Use	Quality Class	Primary Water Quality Criteria
Drinking water source without conventional treatment but with chlorination	A	Total coliform organisms (MPN*/100 ml) shall be 50 or less pH between 6.5 and 8.5 Dissolved Oxygen 6 mg/L or more, and Biochemical Oxygen Demand 2 mg/L or less
Outdoor bathing (organized)	B	Total coliform organisms (MPN/100 ml) shall be 500 or less pH between 6.5 and 8.5 Dissolved Oxygen 5 mg/L or more, and Biochemical Oxygen Demand 3 mg/L or less
Drinking water source with conventional treatment	C	Total coliform organisms (MPN/100 ml) shall be 5000 or less pH between 6 and 9 Dissolved Oxygen 4 mg/L or more, and Biochemical Oxygen Demand 3 mg/L or less
Propagation of wildlife and fisheries	D	pH between 6.5 and 8.5 Dissolved Oxygen 4 mg/L or more, and Free ammonia (as N) 1.2 mg/L or less
Irrigation, industrial cooling and controlled disposal	E	pH between 6.0 and 8.5 Electrical conductivity less than 2250 micro mhos/cm, Sodium Absorption Ratio less than 26, and Boron less than 2 mg/L

Drinking Water Specifications: [12, 13]

The Bureau of Indian Standards (BIS) earlier known as Indian Standards Institution (ISI) has laid down the standard specifications for drinking water (BIS, 1991). In order to enable the users,

exercise their discretion towards water quality criteria, the maximum permissible limit has been prescribed especially where no alternate sources are available. The national water quality standards describe essential and desirable characteristics required to be evaluated to ascertain suitability of water for drinking purpose. The important water quality characteristics as laid down in BIS Standard are given in Table 1. Ground water specifications for drinking given in Table2.[12]

Table 2. Ground water specifications for drinking (IS: 10500:1991)

S.No.	Characteristics	Desirable limit	Permissible limit
Essential Characteristics			
1	Colour, Hazen units, Max	5	25
2	Odour	Unobjectionable	-
3	Taste	Agreeable	-
4	Turbidity, NTU, Max	5	10
5	pH value	6.5 to 8.5	-
6	Total hardness ($CaCO_3$), mg/L, Max	300	600
7	Iron, mg/L, Max	0.3	1
8	Chlorides, mg/L, Max	250	1000
9	Residual free chlorine, mg/L, Max	0.2	-
Desirable Characteristics			
10	Dissolved solids, mg/L, Max	500	2000
11	Calcium, mg/L, Max	75	200
12	Magnesium, mg/L, Max	30	75
13	Copper, mg/L, Max	0.05	1.5
14	Manganese, mg/L, Max	0.1	0.3
15	Sulphate, mg/L, Max	200	400
16	Nitrate, mg/L, Max	45	100
17	Fluoride, mg/L, Max	1	1.5
18	Phenolic compounds, mg/L, Max	0.001	0.002
19	Mercury, mg/L, Max	0.001	-
20	Cadmium, mg/L, Max	0.01	-
21	Selenium, mg/L, Max	0.01	-
22	Arsenic, mg/L, Max	0.05	-
23	Cyanide, mg/L, Max	0.05	-
24	Lead, mg/L, Max	0.05	-
25	Anionic detergents	0.2	1
26	Chromium as Cr^{6+}, mg/L, Max	0.05	-
27	PAH, mg/L, Max	-	-
28	Mineral oil, mg/L, Max	0.01	0.03
29	Pesticides, mg/L, Max	Absent	0.001
30	Alkalinity, mg/L, Max	200	600
31	Aluminium, mg/L, Max	0.03	0.2
32	Boron, mg/L, Max	1	5

In water quality control technology, the principal indicator of suitability of water for domestic, industrial or other uses is the coliform group of bacteria. The density of coliform group is the

criteria for the extent of contamination and has been the basis for bacteriological water quality standard. In ideal situation all the samples taken from the distribution system should be free from coliform organisms but in practice, it is not attainable always and therefore, following standard for water has been recommended (BIS, 1991):

1. 95% of water samples should not contain any coliform organisms in 100 ml throughout any year.
2. No water sample should contain E.Coli in 100 ml water.
3. No water sample should contain more than 10 coliform organisms per 100 ml.
4. Coliform organisms should not be detected in 100 ml of any two consecutive water samples.

However, from bacteriological point of view, the objectives should be to reduce the coliform count to less than 10 per 100 ml and more importantly the absence of faecal coliform should be ensured.

Further, the presence of faecal colifirms in ground water is the indicator of a potential public health problem, because faecal matter is a source of pathogenic bacteria and viruses. The faecal coliform bacteria contaminate ground water through percolation from contamination sources (domestic sewage and septic tank) into the aquifers and also because of poor sanitatory system. [13]

CONCLUSION:

Present review deals with the detailed study of Ground water, its sources & Ground water contaminants. Groundwater should be according to BIS & WHO specification for drinking so that should not harm to human body after drinking.

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