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A Brief Review on the Surface and Ground Water Quality and its Impact on Human Health

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Abstract : By far the most serious and ominous problem the world is facing today is the problem of water pollution. In spite of adopting various measures in existence so far to check the pollution, the situation is worsening day by day due to rapid industrialization, urbanization and exponential growth in population. Moreover, reckless exploitation of water resources to meet the growing demands without paying heed towards sustainability factors has deteriorated the situation furthermore.

All major rivers of our country are facing problems of water pollution. Even underground water in getting polluted and not safe to drink. Groundwater at many places in the state has been found to contain arsenic, fluoride beyond permissible limit. Similarly in some areas high concentration of iron in groundwater has been reported.

Keywords : Water Pollution; Surface water Quality; Ground Water Quality; Physico-chemical characteristics; Biological Characteristics.

Introduction

It is worth mentioning here the words of Dr. Masaru Emoto, chairman, International water for Life Foundation Japan who else where says – Water is almost living and as sensible as we are; good music can positively affect water ; water can positively react to good or bad words, peace or war, love and prayer, water can copy what it was shown and as such we should love and respect water because words have vibration and spirits. In the words of Dr. Hashmat Ali, Environmental Science Research Unit, post graduats department of Chemistry, S.K.M. University Dumka, Jharkhand (India) – "Water is almost living and as sensible as we are is quite comprehensible if we take the things on spectroscopic plane", if we utter good words to water, thereby emit such radiation that make alignment with the internal energy (Vibrational, rotational, electronic etc.) possessed by water molecule and good comes out of it. Liking and disliking attitudes shown by water molecule for the incident energy have experimentally been verified through the varied shapes and structures of water molecule displayed when photographed under different conditions.

Water is a precious and most community used resources that form the basis for existence of the entire living organism. Regular and plentiful supply of clean and pure water is a prerequisite for the survival and maintenance of healthy life. Around the 5th Century B. C. Greek philosophers like Pinder proclaimed that water is the best of all things and Empedocles of Agrigentum postulated that water was one of the four primary elements or roots from which all materials of the word were constituted. Water is used for a variety of purposes, the most basic of which is for drinking and personal hygiene.

Water is the prime necessities of life. We can hardly live for a few days without water. Man's progress will be tremendously hindered if good quality of pure water is not readily available to them in adequate quantity. Good quality of water means the water, which is colourless (in thin layers) or blue-green (in thick layers) having neither odour nor taste.

However, all major rivers of our country are facing problems of water pollution. Even underground water in getting polluted and not safe to drink. Groundwater at many places in the state has been found to contain fluoride beyond permissible limit (standard level=1 to 1.5 ppm). Similary in some areas high concentration of iron in groundwater has been reported. The standard acceptable limit in the case of iron is 2 ppm. Problem of arsenic are also to be found at different places in the state of West Bengal. River flowing through the coalfields of Jharkhand have been reported to carry arsenic responsible for arsenic poisoning in downstream areas of West Bengal. As a result of fall in groundwater tube-well and deep bore wells, the groundwater has been contaminated with iron, fluoride and arsenic.

Effluents discharged from mine sites have seriously polluted the streams and underground water throughout the globe. Acid mine drainage, liquid effluents from coal handling plants, colliery workshops and mine sites and suspended solids from coal washeries have caused serious water pollution throughout the country and the world over thereby adversely affecting fish and aquatic life. River in West Bengal receive wastes from many industries situated on banks.

Pollution of Surface Water

Surface water being exploited form time to time, may become short of supply or may not be easily available at site. Those, who have privilege of having river nearby their area, the latter (river) become the primary source of drinking water. In India as well as in most developed and developing countries people use the river and spring water for drinking purposes. Important among them are Australia, Austria, Brazil, France, Japan, Korea, Nigeria, Spain, U. K. and U. S. A.

During recent past these resources have become polluted throughout the world and have created hazardous effect on human beings. Most Pollution originates from disposal of municipal waste water, industrial effluents, and agricultural runoff and through miscellaneous waters. Out of five people one gets safe drinking water and about 123 cores of people do not have sufficient water for drinking in the world.

Ground Water Pollution

Ground (Sub-surface and underground) water resource is widely distributed all over the world. The ground water is of uniform character and relatively free from harmful bacteria and can be extracted at a small capital cost in a short time. So there has been an increase in ground water development and utilization particularly in developing countries for agriculture, industries and domestic purposes[1]. Recent studies revealed that nationwide 75% of public water supplies use ground water as a raw water sources and nearly 100% of private domestic water supplies rely on ground water as a drinking water source[2]. In India, large scale ground water investigation programmes have been taken up in Rajasthan, Gujrat and Tamilnadu with the assistance of the UNDP (United Nations Drinking water Programme). The Canadian assisted project in Andhra Pradesh, the upper Betwa river, Basin Project in Madhya Pradesh and Uttar Pradesh with the assistance of United Kingdom, Narmada valley Project in Madhya Pradesh, vedavanthi and Tunabhandra river basin Project in Karnataka and many such Project have been undertaken. Since 1970 major programme with the assistance of UNICEF for provision of drilled wells for rural water supplies have been launched in the hard rock area of Andhra Pradesh, Karnataka, Madhya Pradesh, Maharastra, Rajasthan and Tamilnadu. In February 1975, New Internationalist claim that out of 1,50,000 bore holes (boring) in India 90,000 did not remain under operation at any one time because of pump break down[3]. Thus, any natural or artificial disturbance in these sources makes the water importable for human consumption. The U. S. Environmental Protection Agency (U. S. E. P. A.) have identified 546 hazardous sites. Four hundred of these pose some threat to underground sources of drinking water. These sources of ground water pollution are closely related with human use of water[4,5]. Hence, the ground water pollution may be confined as "the artificially induced degradation of natural ground water quality[6]". For extensive literature on ground water pollution including causes, occurrence, procedures for controlled and methods for monitoring may be available from classical work; POLLUTED GROUND WATER by Todd and MC Nulty[5]. Important contribution on ground water can also be found in journals of Civil Engineering, water

resources water supplies, Geology, Geo-Physics, Agriculture and soil Science[7]. The serials ground water journals of Hydrology and water well journal published by the National water well Association have been indispensable for professionals concerned with the development and management of ground water resources[6].

The International Institute of applied system analysis in Australia (I IASA) has warned that water pollution will be India's major problems in 25 years unless sewerage and sanitary facilities are improved. It was said that the accumulated human wastes could mix the open water resources resulting in epidemics. Ellis and Mc Calla identified more than 20 diseases that potentially can be transmitted from animal wastes to human by bacterial contamination of water supplies[8]. About 135 crores of people are suffering from different disease due to insanitary condition. A rough estimate says that about 25 thousand people die every day due to water-borne disease in which the maximum number is of children.

The history of sanitary water bacteriology dates back to 1880, when Fritsch referred to certain mixed organisms in water as the indicator of fecal pollution. A few year after Escheriachia coli (bacillus Coli) was identified as an indicator of fecal contamination. Since then, affords for detecting the presence of the pathogenic organisms have advanced much and currently colli form group has been developed to include all aerobic and facultative anaerobic Gram negative non spore forming rod shaped bacteria that ferment lactose with gas production within 48 hours at 35□C. Some recent advances have revealed that the concept of total coliform as indicator species is not a reliable approach to assess the pollution, because of its fecal as well as non-fecal origin[9,10(a),10(b)]. Due to the variation in Coliform origin, micro-biologist have attempted to find other bacteria of fecal origin, which are more specific. The closest bacteria was found to be streptococci. Still there is no agreement among sanitary bacteriologist over the use of total Coliform, faecal Colliform or fecal streptococci as the conclusive indicator of faecal pollution assessment of water quality is based on two parameters i.e., chemical and biological water resources.

Surface Water Quality

1. River Water

Recently, In India, characteristics of the Ganga river has been studied at several places with special reference to its abiotic and boitec composition. Lakshminarayan studied the phytoplankton in relation to physico chemical conditions of river Ganga at Varanasi[11]. Pahwa and Mehrotra concluded their investigations based on 1090 kms stretch of Ganga[12], extending from Kanpur in the west to Rajmahal in the east. Based on the physico features and ecological conditions the entire observed stretch was divided into three zones. Bhagalpur was kept under recovery zone where the water current remained somewhat slow during summer months. Bilgramihas studied the effect of industrial wastes on the hydrobiological status of the river Ganga[13(a),13(b)] from Mokama to Barauni. Limnological survey and impact of human activities on the river Ganga, a project under MAB programme was carried out by Bilgrmi and Datta Munshicovering a stretch of 256 kms from Barauni to Farakka[13(a)]. Subsequently, Bilgrami and Datta Munshi made another limnological Survey of the river Ganga from Patna to Farakka[14], whereas Bilgrami studied water quality of river Ganga[15] and marked the polluted sites from Patna to Bhagalpur. Singh[16,17] Siddiqui[18], Tripathi[19] and Tiwari[20] made systematic Survey of algal flora of the river Ganges and investigated the impact of some ecological factors on it. Rizwi enumerated taxonomic and distribution of aquatic and extra-aquatic fungi of river Ganga at Bhagalpur[21]. Singh studied physico-chemical characteristics of water and quantitative study of Plankton of the river Ganga at Bhagalpur[22]. Bhargava studied seasonal variation and concluded Physico-chemical and bacteriological properties of river Ganga[23] from Rishikesh to Varansi. Pollutional status of the Ganga water near Palta, West Bengal was carried out by Sinha and Banerjee using Physico-chemical and bacteriological characteristics[24]. Kant found direct correlation of phytoplankton productivity in relation to physico-chemical properties of river Ganga at Buxar[25]. Sinha studied only physico-chemical factors[26] at Dalmu (Rai Bareli),Yadava and Bhownick studied biological spectrum of river Ganga[27] from Munger to Farakka whereas Bilgrami investigated ecological complexities of the river Ganga at Bhagalpur[28].

2. Municipal Water

Generally untreated or unchlorinated or raw water gives taste, odour and colour problems and decrease the palatability of water. There are chances of outbreak of different water-borne diseases due to use of raw water. For the sake of that, treatment of raw water is required. River is the major source of water supply in the

cities. Among the best known waterworks are those supplying drinking water in London and Paris from the Thames and the Seine rivers respectively[29]. Besides, many developed and developing countries including India also use surface (river) water for treatment and drinking purposes. There are scanty reports on Municipal water supply. Hugy and Olson isolated filamentous fungi from municipal water supply together with the assessment of physico-chemical and bacteriological parameter from chlorinated and unchlorinated municipal water supply in Canada[30]. Rosenzweig also isolated fungi from potable water distribution system in U.S.A[31]. Lechevellier isolated a number of bacteria from treated water at Montana[32]. Bernard made automatic detection of Coliforms bacteria from drinking water supply in France[33].

In India, Dannis[34], Bewtra[35], Datta and Nataarajan[36], Panicker[37], Godbole and Walble[38], Shrama[39], Garud[40], Kumar[41], Saha[42(a)], Kundargar[42(b)], Kumar[43(a),43(b)] Kumar and Saha[44,45] and Saha and Kumar[46] worked on different aspects of municipal water supply. Dannis[34], studied on bacteriological quality of municipal water supply and found epidemics in Delhi. Bewtrastudied Hydrological quality of municipal water supply at Agra[35]. Sharma also studied on the water pollution of river Yamuna and its influence on drinking water supplies of Agra cities[39]. Datta and Natrajan studied physico-chemical analysis of drinking water supply in Pondicherry[36]. Godbole and Wable[38] studied bacteriological properties and concluded that there are occurrence in municipal water supply is due to fecal contamination. Saha investigated physico-chemical and bacteriological properties of municipal water[42(a)] and compared it with other sources of drinking water at Bhagalpur during monsoon. Kundangar studied physico-chemical and Phytoplankton species from municipal water[42(b)] supplies at Srinagar and compared the data of municipal water with that of polluted water of river Jhelum. Kumar recorded the occurrence of philamentous fungi and municipal supply and zooplankton composition in different drinking water sources at Bhagalpur[43(a),43(b)]. Kumar and Saha studied the physico-chemical and bacteriological quality of drinking water[44,45]. Saha and Kumar investigated comparative quality of potable water at Bhagalpur[46].

Ground Water Quality

1. Hand pump water

In recent past the hand-pump water had diminished in quantity and degraded in quality because of excessive pumping, reduction of natural recharge, owing to urbanization, increased application of chemicals, waste water disposal practices and other contamination activities[47]. Literature on quality of hand-pump water is scarce, though most of the workers are restricted only on physico-chemical and bacteriological properties of water. A few are related with comparative study of hand pump water with other sources. Important among them are Mathur and Ramnathan[48], Olaniya[49], Phirke[50], Alberts and Spomer[51], Saha and Pandit[52], Lakshman[53], Rao[54], Saha[42(a)], Das Gupta and Ghosh[55], Mascher[56], Saha and Pandey[57], Kumar and Saha[44,45] and Saha and Kumar[46].

Mathur and Ramanathan reported bacteriological quality of hand-pump water at Roorke[48]. He concluded that presence of entercocci in hand pump water are indicative of faecal contamination. Olaniya studied the physico-chemical characteristics of hand-pump water at Jaipur[49]. Phirkeetal studied the Physico-chemical and bacteriological properties of hand pump water at Delhi[50]. Saha and Pandit[52], Saha[42], Kumar and Saha[44,45] and Kumar[43(b)] studied comparative study of different water. They enumeriated physico-chemical and bacteriological quality of hand-pump water at Bhagalpur. Lakshman found more than 45 mg/ l nitrate nitrogen concentration in hand-pump water in twin city of Hyderabad and Secunderabad[53]. Rao studied the physico-chemical properties of hand-pump water of Nuzvid town of Andhra Pradesh[54]. Das Gupta and Ghosh found variation in chemical parameters of hand-pump water in North Bihar[55].

2. Well Water

Excavation at Mohanjodaro revealed that the brick- lined dug wells were existing during 3000 B. C. during the Indus valley civilization. The writings of Vishnu Kautilya in the regime of Chandra Gupta Maurya – 300 B. C. indicate that ground water was being used for irrigation purposes at that time[6]. Dating from Biblical times, dug wells have furnished countless water supplies throughout the world. Sinking of the wells and a variety of water devices were well developed from vedic time[6].

Because of soil filtering mechanism well water is considered to be free from bacteriological population and safe source of drinking water[2]. Yet, proliferation of microbes in wells has been emphasized by several workers. Gerba summarised literature on subject and indicated that the accumulation of organic matter in the

soils around the well casing promote the growth of micro organisms such as coliform bacteria[58]. Smith indentified that the possibilities of the contamination of well water are through soil[59].

Extensive works on the quality of well water, sources of contamination and composition of abiotic and biotic factors have been carried out in many developed countries. Young Gwan studied bacteriological quality of well water at Pasan, south Korea[60]. Collins[61] reviewed the bacteriological quality of well water and detected Mycobacterium sp. (Causal organism of Tuberculosis) from the source in London. Benode found M. gordonal in well water in Italy[62], Stover[63]studied physico-chemical and Biological properties and required treatment for cleaning up of contaminated ground water at hazardous waste dump site at Oklahoma in Indiana. Alberts and spomer[51] described about the conservation of well water by nitrate-nitrogen and phosphorus contamination at Columbia, Missouri. Overgaard[64] reviewed about the nitrate nitrogen contamination in well water at Copenhagen, Denmark and highlighted this problem in UNESCO MAB workshop on the sub-surface water resources by nitrate and other pollutants at Budapest. Slade studied physico chemical properties and found viruses and bacteria from a well in London[65]. Antai reported that coliform contamination was greater in well water than in river or stream water at port Harcount[66], Nigeria and studied the mechanism of contamination of ground by septic tank percolation system at Garching. F. R. G. Sworobuk[2] assessed the bacteriological quality of rural ground water supplies in Northern West Virginia. Wickramaniyake studied physico-chemical bacteriological and disinfection by chlorine of ground water obtained from 200 m deep wells at Bangkok, Thailand[47].

In India, a number of workers have studied the physico-chemical bacteriological and biological qualities of well water. Bagchi studied bacteriological quality of well water and suggested not to use such open wells having higher bacterial count at Sarojini Nagar in Lucknow district[67]. Kaushik isolated different species of bacteria, and recorded a number of phytoplankton and zooplankton from the wells[68]. Kaushik and Prasad found seasonal variation in coliform and entercocci organism in well waters[69]. Kaushik and Bewtra[70] and Mathur and Ramanathan[48] also observed the incidence of coliform and enterococci in well water and assessed the true sanitary significance. Arora and Moghe recorded Brachionus sp and many rotifers from the well water[71]. Aboo also studied hydrobiological quality of well water in Bhopal city[72]. Olaniya investigated physico-chemical characteristics of well in Jaipur city[49]. Sridhar and Pillai[73] have shown that the ground water has become polluted at Bangolore near the septic tanks. Olaniya and Saxena[74] found ground water pollution by open refuse dumps at Jaipur. Further, Olaniya[75] studied pollutional studies of well water in sewage farms at Jaipur. Narayana and Rao[76] studied bacteriological quality of well water at Warangal, Andhra Pradesh and attributed that this is due to domestic waste water seepage from septic tanks. Trivedy[77] evaluated well water in Satara district of Maharastra. Mahadewan and Krishnaswamy studied physico-chemical and bacteriological properties of well water at Madurai[78]. Naganna studied well water contamination due to seepage from polluted river[79]. Saha studied comparative study dealing with physico-chemical and bacteriological properties of well water at Bhagalpur during monsoon[80]. Lakshmanan investigated and recorded maximum concentration of nitrate-nitrogen in well water in twin cities of Hydrabad and Secunderabad[53]. Rao[54] described physico-chemical quality of well water of Nuzvid town, Andhra Pradesh. Das Gupta and Ghosh[55]studied well water quality in North Bihar. Kumar made a comparative study of physico-chemical and bacteriological properties of well water[81].

3. Deep Tube well Water

Water of deep tube well is supposed to be free from contamination and less harder than handpump and well water but there are reports of contamination and proliferation of bacteriological concentration in such soruce. Burker isolated Aeromonas hydrophilia from a metropolitan domestic water supply from deep tubewell of Australia and studied seasonal correlation with clinical, isolates[82,83]. Overgaad observed nitrate pollution of 2800 deep tubewell water source in Denmark[64]. Although the reports on deep tubewell water is very scanty in India. Yet few Indian workers have contributed a fragmentary work on the above topic. These workers are Mathur and Ramanthan[48], Olaniya[49] Bishnoi[84], Brar[85], Saha and Pandit[52] Lakshmanari[53] Rao[54], Saha[42], Dhaneshwar[86] and Das Gupta and Ghosh[55].

Mathur and Ramanathan studied bacteriological quality of deep tubewell water at Roorkee[48]. Olaniya, studied physico-chemical quality of deep tubewell water in Jaipur city[49]. Bishnoi investigated the quality of deep tube-well of Dhuri Block in Sangrur district (Punjab)[84]. Brarstudied hydro-chemistry of deep tube-well water of Bhawaingarh Block, Sangrur district[85]. Saha and Pandit[52] studied physico-chemical characteristics of deep tubewell water at Bhagalpur, whereas Rao[54] studied the drinking water quality in Nuzvid town of Andhra

Pradesh. Saha et al made comparative study of different source along with deep tube well water during monsoon. Dhaneshwar[86]and Das Gupta and Ghosh[55] have also studied physico-chemical characteristics of deep tube-well. Water at Kanpur and in North Bihar respectively.

Physico-Chemical Characteristics

An understanding of the different abiotic and biotic characteristics of the drinking water is essential for assessing its quality. The sources of pollution of groundwater can be traced by chemical and bacteriological methods. In groundwater studies, the temperature is particularly important in places, where there are wide variations. As compared to large seasonal variation of surface water temperature (except in tropical regions) ground water temperature tends to remain relatively constant, an important advantage for drinking water and industrial use[6]. The mean of many analysis presented by Livingstone[87] suggests that the world's rivers contain an average of about 120 mg/L of total dissolved solids (TDS). Kresse studied the exploration of ground water contamination of Novato and detected it by the presence of different electrolytes in water by electrical conductivity[88].

pH is an important factor influencing the distribution and species composition of running water[89]. Calcium bicarbonate of different water is the source, which regulates the pH. According to Hutchinson[90] and Pattet[91] the amount of D_2O at any place gives a comprehensive picture of the nature and content of pollution. Normally, dissolved gases in ground water can pose hazards if their presence goes unrecognized. Percolating rain water contains CO_2 derived from the atmosphere and from inorganic processes in the soil, assists the solvent action of water as it moves underground[92] Bicarbonate, usually the primary anion in ground water is derived from carbon dioxide released by organic decomposition in the soil. Salinity varies with specific surface area of time. The values tend to be highest, where movement of ground water is least. Hence, salinity generally increases with depths. Several workers[90,93] have discussed in detail the phosphate chemistry in natural waters. Russo[94] described that ammonia nitrate and nitrate contamination in water sources is by the discharge of industries, municipal and agricultural waste water of runoff. Occasionally nitrate is an important natural constituents, so their presence in high concentration may indicate sources of past or present pollution. Alberts and Spomer studied the dissolved nitrogen and phosphorus in the runoff from watershed in conservation and conventional tillage[51]. In ground water silicate mineral of igneous rocks result in Silica being added to the ground water. Occurrence of chloride in ground water remains up to a limited extent under normal conditions and in certain circumstances, it is added from inflow of sewage and polluted water. Ion exchange involves the replacement because the exchange involves principally cations (sodium, calcium and magnesium) and the process is known as base or cation exchange. The direction of the exchange is towards an equilibrium of bases present in the water and on the finer materials of the aquifer.

Mc Feters and Sturart[95]; Devenport[96]; Verstrate and voets[97]; Beuchat[98], Faust[99], Anderson[100], Gameson[101] and Hirashi[102]; have also studied the effect of temperature on the growth and distribution of faecal bacteria in aquatic systems. Griegby and Kavkins[103], Fujoka[104], Gameson[101]and Bracina[105]have also studied the efforts of solar radiation on bacterial growth and reported its lethal effect against bacterial growth. Effect of ultraviolent radiation on indicator bacteria was studied by Kapuscinsik and Mitchel[106] and Ray and speak[107]. Kralovic and Wilson[108]; Smith and Palumbo[59]; Carison-Gunoe[109]; studied the effect of pH on the survival and growth of coliforms in aquatic systems. Rai and Hill reported the role of turbidity in supporting the growth of heterotrophic bacterial population. Cairns[110] suggested that particulate materials suspended in water provide a vast amount of surface area for the growth of fungi and bacteria. Peavy reviewed the importance of total solids in drinking water and reported that certain dissolved solids are harmful for human beings[111]. Water hardness is not very important from public health point of view. However, Kobayashi[112] reported statistical correlation between water hardness and cardiovascular diseases and reported lower incidence of this disease in the area having higher values of hardness in drinking water, whereas NRC[113] found negative correlation in between the two. Role of phosphate in enhancing the growth of micro organisms have been studied by Hutchinson[90], Hepher[114], Odum[115], Wetzel[116], Costa and DeSilva[117] and Currie and Kalff[118]. An inverse correlation between phosphate concentration and bacterial density has been reported by Rai and Hill[119] in the river water. The occurrences of arsenic, fluoride and nitrate, iron and nature of sediments of the water-bodies and their chemical composition are separately discussed below.

1. Occurrences of Arsenic in Groundwater

Several studies suggested that the groundwater arsenic contamination is mostly restricted to the alluvial aquifers of the Ganges delta comprising sediments carried from the sulphide-rich mineralized areas of Bihar and elsewhere surrounding the basin of deposition[120,121]. However, recent studies indicated that the vast tract of Indo-Gangetic alluvium extending further to the west and the Brahmaputra alluvium have elevated concentrations of arsenic in wells placed in the late Quaternary and Holocene aquifers. Arsenic released during the weathering of sulphide minerals is generally adsorbed onto the surface of iron oxy-hydroxides that precipitated under oxidizing conditions normally prevailing during the deposition of the Holocene sediments. However, redox processes in the sediments triggered the reductive dissolution of iron oxides that transferred substantial amounts of arsenic in aqueous phases through biogeochemical interactions. Arsenic-containing groundwater in Ganga–Brahmaputra River basin is hosted by the sediments deposited by the rivers during the late Quaternary or Holocene age (< 12 thousand years). Lithology of those late Quaternary sediments includes sands, silt and clay. Mineralogical composition of those sediments consists of quartz, feldspars, illite and kaolinite and the fine-grained over bank facies are rich in organic matter[122,123]. There is a thick layer of newer alluvium containing sand, silt and clay, which spread out by numerous rivers that originate from the Himalayas both in the north and northeast. Most environmental arsenic problems, recognized so far, are the result of mobilization under natural conditions. Thus, the occurrence of arsenic in groundwater in the BDP and Gangetic plains has been recognized as of geological origin with spread out resulting from the mobilization under natural hydro-geologic conditions.

2. Occurrence of Fluoride and nitrate

Occurrence of fluoride in groundwater in different parts of the world and prevalence is dental fluorosis among children led the scientists to study the physico-chemical quality of drinking water. Fluoride and nitrate are of much importance from public health point of view. Raghavachri and Venkatramanan[124] first tried to correlate the depth of the well and fluoride content of water. Comely[125] for the first time reported the role of nitrate-nitrogen in causing cyanosis among infants. Subsequently weart[126], Waring[127], Mc Letchie and Robertson[128], and Walton[129] supported his view. Magee and Barness[130] and Bogovski[131] reported that excessive intake of nitrate may have carcinogenic effects on animals. Very few works have been done on the statistical correlation of nitrate-nitrogen with other physico-chemical parameters.

3. Occurrences of iron in Groundwater

Iron is the second most abundant metal in the earth's crust, of which it accounts for about 5%. Elemental iron is rarely found in nature, as the iron ions Fe^{2+} and Fe^{3+} readily combine with oxygen- and sulfur-containing compounds to form oxides, hydroxides, carbonates, and sulfides. Iron is most commonly found in nature in the form of its oxides.

Iron (as Fe^{2+}) concentrations of 40 μg/litre can be detected by taste in distilled water. In a mineralized spring water with a total dissolved solids content of 500 mg/litre, the taste threshold value was 0.12 mg/litre. In well-water, iron concentrations below 0.3 mg/litre were characterized as unnoticeable, whereas levels of 0.3–3 mg/litre were found acceptable.

In drinking-water supplies, iron(II) salts are unstable and are precipitated as insoluble iron(III) hydroxide, which settles out as a rust-coloured silt. Anaerobic ground waters may contain iron(II) at concentrations of up to several milligrams per litre without discoloration or turbidity in the water when directly pumped from a well, although turbidity and colour may develop in piped systems at iron levels above 0.05–0.1 mg/litre. Staining of laundry and plumbing may occur at concentrations above 0.3 mg/litre.

Iron also promotes undesirable bacterial growth ("iron bacteria") within a waterworks and distribution system, resulting in the deposition of a slimy coating on the piping.

Iron is used as constructional material, *inter alia* for drinking-water pipes. Iron oxides are used as pigments in paints and plastics. Other compounds are used as food colours and for the treatment of iron deficiency in humans. Various iron salts are used as coagulants in water treatment.

4. Nature of sediments of the water-bodies and their chemical composition

The nature of sediments of the water-bodies and their chemical composition influence the aquatic vegetation in much the same ways as they affect the terrestrial vegetation[132]. Although some reports are available on bottom soil analysis of various water systems (Singh and Singh[133], Mishra and Purohit[134]; Tripathi,[135], Rai[136]; Satpathy[137]; Saha,[138] Bilgrami and Datta Munshi[139], Pandit[140]; Saha and Pandit[42(a), 141] Choudhary[142] Dasgupta and Ghosh[55], Kumar and Saha[143]). The chemical characteristics of well bottom soil have not received proper attention. Hynes stressed that the steam substratum is a major factor in controlling the distribution of running water. Bilgrami and Datta Munshi[14] worked on the impact of human activities on the bottom soil characteristics of certain stretches of the river Ganga. Saha and Pandit[144] made comparative study of bottom soil properties between pond and reverline systems at Bhagalpur. Choudhury[142] studied physico-chemical nature of submerged soil of river Ganga from Sultanganj to Bhagalpur. Das Gupta and Ghosh[55] analysed the physical and chemical/properties of soil of North Bihar. Kumar and Saha[143] studied the chemical nature of bottom soil between the river of bottom soil between rivers and wells at Bhagalpur.

Biological Characteristics

As certain coliform organisms are normally found in intestines of man beings and animals[145], the presence of these in drinking water sources is dependent on its contact with sewage sources. The bacterial transport to water supplies has been linked to the erosion process and overland flow[146]. The presence of these faecal coliform or coliform group as whole become causative of faecal oral disease such as dysentery, cholera, diarrhea, typhoid, paratyphoid, shigellosis, Salmonellosis, etc. Hence, work on the occurrence of bacteria and their effect on the human beings have been studied by several workers in India and abroad. Hiraishi[102] studied the relationship among total coliforms, faecal coliforms and organic pollution in the Tamagawa river in Japan. Barcina[105] studied factors affecting the survival of Escherichai coli in river in Spain. Martins[147] made 10 years survey on Salmonella and Enterovirus in raw and treated aters in the great Saopaulo area of Brazil. Antai[66] studied the incidents of Staphylococcus aureus, coliforms and antibiotic resistant strains of Escherichia coli in rural water supplies in port Harcourt, Nigeria. Mascher[56] studied bacteriological properties of drinking water in district of Melut (upper Nil province), Austria. Young Gwan[60] studied bacteriological quality of ground water in Pusan area, South Korea. Burke isolated Aeromonas hydrophilic from surface and underground water sources of a metropolitan supply in Australia. Berke[83] also isolated Aeromonas Sp from an unchlorinated water supply in Australia. Sworobuck[2], assessed the bacteriological quality of rural ground water supply in Northern waste Virginia. Wickramanayake[47] studied the effect of chloride disinfection on inactivation of coliforms bacteria E, coli of ground water at Ohio, U.S.A.

Dennis[34] studied MPN coliform in supply water at consumer site resulted in outbreak of diseases in Delhi. Phirke[50] studied bacteriological quality of hand-pump water in Delhi. Bagchi[67] had reported that water from the open wells in the village around rural Health Centre, SarojniNagar in Lucknow district was quite unfit for human consumption. Kaushik[68] investigated bacteriological qualities of wells in rural Delhi. He also described that 93% of the wells were unsuitable for drinking purposes, whereas 77% wells were heavily polluted with coliforms having index value above 1100. Kaushik and Prasad[69] studied seasonal variation of coliforms and Enterococci in well waters. Subsequently in 1965, Kaushik and Bewtra found incidence of coliforms and Enterococci in natural water. Aboo[72] made a survery of the background quality of well water in Bhopal city. Olaniya[75] made pollution studies of well water bacteriologically in sewage farm in Jaipur. Narayan and Rao[76] studied Warangal well waters bacteriologically at Jaipur, Mahadevan and Krishna swamy[78] studied bacteriological quality in well water in Madurai, South India and Saha[141] at Bhagalpur. Kumar[81]studied physico-chemical as well as bacteriological properties of wells at Bhagalpur. Kumar and Saha[44,45,43] also studied the comparative quality of physico-chemical and bacteriological characteristics of different drinking water sources at Bhagalpur.

Impact on Human Health

Thus, the changes in the physical, chemical, biological, fungal and bacteriological factors of water systems deteriorate the quality of water substantially. Such alteration in water quality is of Public health hazards and is associated widely with the causes of the different water borne diseases. In the developed world related diseases are especially due to the presence of effective water supply and proper waste water disposal systems. However in the developing world more than 2000 million people are without safe water supply and adequate

sanitation. Three major effects of organic pollutants in human systems i. e. carcinogenic, mutagenic and teratogenic have been reported by World Health Organization (WHO). According to WHO in developing countries 30000 people die each day from water borne disease. 80% of all illness is water related and 400 million people are suffering from gastro-enteritis. A recent survey of eight developing countries showed that the 90% of the child death could be avoided by safe supplies, hygienic sanitation and proper sewage disposal.

In India 80% of the diseases are also water-borne and river Ganga is supposed to be one of major contributers. Therefore, it is the prime duty of every human being to make his utmost efforts for pollution abatement and protect it from different contaminants.

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