Qualitative aspects of Ground water for Drinking purpose of Phagi Block of Jaipur District (Rajasthan)

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ABSTRACT :-

Ground water qualities of Phagi Block of Jaipur district in Rajasthan were studied post mansoon (Oct. 2016) to assess its suitability for drinking purpose. Water samples from eleven different villages of Phagi Block were collected and seventeen physico-chemical parameters were analysed and values obtain were compared with standard values recommended by Bureau of Indian standards (BIS), Indian Council for Medical Research (ICMR), World Health organization (WHO) and United States Public Health (USPH) Standards. The corresponding water quality indices (WQI) were also worked out and reported. Analysis of results showed that water is unsuitable for drinking purpose.

Key Words :- *Water Quality index, Ground Water Physico-chemical, water quality, sodium, potassium.*

In the present day living system pollution is the major environmental problem associated with urbanization. With increase in human population surface water is at a greater risk of pollution from anthro-pogenic sources. It is well known that polluted water consumption or deficient sanitation is often the direct cause of out break of water borne diseases. Probably for this reason, the water quality research on natural water for human use has attracted the attention of many workers.

Ground water quality changes are brought through man's introduction of foreign chemicals and biological materials into the sub-surface environment through quantitative interference with natural flow pattern by a completely natural process or through various combinations of these. Most ground water and surface water contains some natural dissolved salts. These salts most often originate from contract of the liquid water involving in the hydrological cycle with various rock, and soil minerals. Similarly water can pick up natural organic matter from leaves, grass and vegetation in various stages of biodegradation as well as dissolved gases native to the atmosphere. The result of the contact is that water accumulates various amounts of natural impurities due to solution or chemical reaction followed by solution. Industry serves as another originator of chemicals for ground water pollution. Most of these sources are localized or point sources. Most often pollution occurs due to leakage from evaporation ponds, holding or oxidation ponds buried wastes landfills and deep well waste disposal activities. From time to time salts may enter ground water due to land spreading of industrial wastes. Seepage from under ground mines and leachate from mine tailings pose other threats. One foreign chemical or biological material has been introduced in the environment it becomes a possible ground water pollutant. Materials introduced near ground level e.g. septic tank leachates subject to a sequence of events including leaching percolation through zone of aeration and introduction into the ground water.

Various workers in our country have carried out extensive studies on fluoride. Das[1] and Co-workers has reported fluoride hazards in ground water in Orissa. Vasudevan[2] co-workers have reported methods for control of fluoride content in ground water. Study of Nitrate concentration of industrial waste water and ground water has also done in our laboratory[12]. Recently Kumar and Gopal[3] has given a review article on fluorosis and its preventive strategies D.Chand[4] has reported fluoride study on human health and patra, Dwivedi[5] & co-workers studied industrial fluorosis on cattle in Udaipur, Rajasthan, Jagdap, Jayashree[6] at al Hussain[7] & co-workers and Abbase[8] et al have studied water quality different rivers. Sriniwas[9] & co-workers and Jha & Verma[10] studied water quality in Hyderabad and Bihar respectively Patnaik[11] et al reported water pollution in industrial area. Fluoride levels and other physico-chemical parameters in drinking water from various sources in and around Jaipur and many villages have been carried out in our laboratory [12-16].

Literature survey reveals that no specific work has been done so far to assess the qualitative aspects of ground water for drinking purpose of Phagi Block of Jaipur District (Rajasthan). Hence present work has been systematic study attempted to investigate the water quality status of this area, from seventeen physico-chemical parameters twelve parameters have been chosen for the calculation of the corresponding water quality index (WQI)[17] which is regarded as one of the most effective way to represent water quality specially for drinking purposes.

MATERIAL AND METHODS :-

In the present investigation an attempt has been made to assess the ground water quality for drinking purpose of Phagi Block of Jaipur District by collecting water samples from eleven location of Phagi block. Name of these location and sources are presented in table No.1. Samples were collected in good quality polyethylene bottles[18] as per the standard procedure. Sampling has been carried out without adding any preservatives in rinsed bottles directly for avoiding any contamination and brought to the laboratory. Monitoring was done after monsoon (Oct.,2016). Reagents use for the present investigation were of AR Grade and double distilled water was used for preparing various solutions. The samples were analyzed as per the standard methods (APHA[19]1992, Trivedi and Goel 1984). Various physical parameters like pH, EC, DO and TDS were determined on the site with the help of digital portable water analyzer kit (CENTURY-CK-710) The chemical analysis was carried out for calcium (Ca^{2+}), Magnesium (Mg^{2+}), Chloride (Cl^{-}), Sulfate (SO_4^{2-}) Carbonate (CO_3^{2}) and Bicarbonate (HCO_3^{-1}) by volumetric tritration methods. While fluoride (F^{-}) by Spectro-photometric (AIMIL-C160-80314) method. The nitrate was estimated at wavelength 220 nm by Ultra violet Spectrophotometer (ELICO-CL-54D) method. Sodium (Na^{+}) and Potassium (K^{+}) by flame photometry (ELICO-CL-220) methods. The respective values for all these parameters are reported in Table No.2 and all results are compared with their standards limits recommended by ISI[20], ICMR[21] and WHO[22]. The standard values for different physico-chemical parameters are shown in Table No.3.

RESULTS AND DISCUSSION :-

The chemical quality of ground water of phagi block of Jaipur District has been investigated to evaluate its suitability for drinking purpose. Hydro-chemical data of the ground water sample have been summarized in Table No. 2. In view of the direct consumption of water by human beings, the domestic water supply is considered to be the most critical use of water. Hydro-chemical data are compared with the standards of Indian standard Institution (ISI-1999), ICMR-1975, WHO-2003 and USPH Standards for identifying usefulness of ground water for drinking purpose.

The physico-chemical data reveals that the pH values of all the water samples are alkaline range. The recorded pH values ranged within 8.40 to 9.21 and these values within the limits prescribed by WHO but except sample S2 (8.40) all of sample have higher values of pH prescribed by ISI and ICMR. It is known that pH of water does not cause any severe health hazard, however high pH induces the formation of trihalomethanes which are toxic (Trivedy & Goel 1986) According to Klein (1973) pH between 6.7 to 8.4 are suitable while pH below 5.0 and above 8.3 are detrimental.

Conductive values varied from 620 to 5520 μ seimens/cm for ground water of phagi block and these values are very much higher than the prescribed standards limits (1400 μ seimens/cm) recommended by WHO except S2, S6, S9 and S10. Higher EC and TDS values reflect greater salinity of water and it cannot be suitable for drinking.

Sodium value varying from 59 to 1071 mg/l all of the studied samples. Sodium value are higher than the prescribed US standard except S2. Sodium is primarily derived from feldspars in igneous rock and its weathering product (clay minerals) in other materials shale and clay layers often yield water with relatively high sodium content. Other sources of sodium are leachate and deep percolation water from the upper soil layers and contamination of ground water by salty connate water or water of marine origin. Brines and other salty water which usually occur at great depth contain large amount of sodium.

Potassium values ranging from 1.76 to 13.8 mg/l. Potassium is less common than sodium in igneous rock but more abundant in sedimentary rock as potassium feldspars. These minerals however are very insoluble to that potassium levels in ground water normally are much lower than sodium concentration.

Calcium values are ranging from 14 to 26.0 mg/l and these values are within permissible limits as prescribed by ICMR and WHO. In human body it is essential for muscular and nervous system cardiac functions and in coagulation of blood. Therefore, low level Calcium may have adverse effect on human health. Sources of calcium are igneous rock minerals like silicate pyroxenes amphiboles, feldspar and silicate minerals produced in metamorphism. Since the solubility of these minerals is low water from igneous or metamorphic rock tends to be low in calcium as well as in TDS.

Magnesium hardness values are varied from 20.0 to 88 mg/l and are within permissible limits as prescribed by ICMR, WHO, ISI and USPH standards. Magnesium rich water may causes the gastrointestinal irritation in the presence of sulfate water containing large amounts of $Mg\text{-}SO_3$ may be purgative and cause the diarrhea amongst the consumers. Magnesium in ground water from igneous rock primarily derives from ferromagnesian minerals like olivine, pyroxenes amphiboles and dark-colored micas.

Sulfate values are varied 12 to 208 mg/l and are within permissible limits as prescribed by ISI, ICMR and WHO. Drinking water should not exceed 250 mg/l of sulfate because water will have a better taste and can produce texative effect of higher levels sulfate formed by oxidation of pyrite and other sulfides widely distributed in igneous and sedimentary rocks. The most important sulfate deposit are found in evaporate sediments (gypsum, anhydrite, sodium sulfate) In arid regions leaching of sulfate from the upper soil layer may also be significant causing sulfate to be the principal anion of the under lying ground water.

Carbonate values ranging from 20 to 120 mg/l carbonate has no standard value for drinking purpose suggested ISI, ICMR, WHO and US standards.

Bicarbonate value ranging from 210 to 810 mg/l. All of the studied samples bicarbonate values are higher than the prescribed by US standards except than S2, S6 and S9 sources of carbonate and bicarbonate include CO_2 from the atmosphere CO_2 sulfate produced by the biota to the soil or by the activity of sulfate reducers and the various carbonate rock and minerals.

Nitrate values vary from 06 to 92 mg/l, all of the studied samples nitrate values are lesser than the prescribed by ICMR, WHO and USPH standards except than S3, and S11 (fig.1). Nitrate occurs naturally in certain water supplies and may also find access to them directly and indirectly through discharge like sewage, wastes etc. Nitrate are dangerous for human health especially in case of infont below six months of age. The ingestion of water directly of indirectly through the milk prepared by powdered milk in water which contains nitrates in excess than 45 mg/l give rise to the pathological conditions. Excessive concentration of nitrate in potable water in considered hazardous for infants because in their intestinal track nitrate (NO_3^{-1}) is reduced to nitrate which may cause Methaemoglobinaemia also called "blue baby syndrome". Researches conducted by British nutrition foundation and cancer research campaign in UK have shown the direct relationship between high in incidences of stomach cancer and the prolonged in take of nitrate rich drinking water. The role of nitrate in goiter genesis had also been discussed for a long-time. Nitrate concentration in excess in drinking water also creates several problems[23] like cyanosis tumors, oral cancer of colon, rectum or other gastriotinal cancers lymphoma dispmia etc.

Fluoride values ranging from 0.80 to 11.70 mg/l (Fig. 2). Among all of the studied samples only one sample S2 is in permissible limits prescribed by ISI, ICMR, WHO and USPH standards, Fluoride concentration less than 0.7mg/l and more than 1.5 mg/l is injurious for health when the concentration of fluoride increases more than 1.5 mg/l it reduced a developmental disease of teeth in the calcification stage of children. The pathological condition becomes evidence from the yellow to brown patches on the teeth and at certain times development of cracks in then this condition well known as 'Mottling' If by chance fluoride exceeds the level of 8 mg/l. It may eventually causes endemic cumulative fluoride with resultant skeletal damage in both children and adults. It affects the skeletal of animals too. In order to better the public water supply a special treatment called as 'Defluoridation' is used. Some important workers contributed their studies of fluoride Ajmal Raziddin [24] (1986)in hand pumps of Aligarh reported 0.90 - 1.15 mg/l fluoride white F^- in the range of 0.0 to 2.10 ppm was observed by Bishnoi[25]et al (1984) in Dhure block of Sangrur district of Punjab. Dhindsa[26]et al (1984) in Kota City noted nil to 1.5 mg/l fluoride. Dwarkanath[27] et al (1994) worked on incidences of fluoride in village Gudalur (Tamil Nadu) Grewel[28] (1976) noticed fluoride in the range of nil to 20.5 mg/l in well water of Punjab. Gupta et al (1993) is ground water of south eastern. Rajasthan reported 0.0 - 5.0 mg/l fluoride due to weathering of rocks. Fluoride is an endemic problem in India while WHO standards permits 1.5 ppm of fluoride safe limit for human consumption Elastic bones, retracted gums and deformed teeth, falling of hairs, swelling in joints have made life miserable. Researches have revealed that competitive and irreversible nature of fluoride compound has led to invalidity for a life time. Total hardness of all water samples are within the permissible limit as prescribed by to WHO, ICMR and BIS ranging from 122 to 427 mg/l as $CaCO_3$ equivalent. As per Durfer and Beker's[29] classification all water samples are hard in nature, which may cause scale deposition and results in excessive soap consumption followed by subsequent scam formation.

Total dissolved solid (TDS) values varied from 398 to 3159 mg/l except S2 remaining all ten samples have higher TDS values than the prescribed standard limit as recommended by ISI, ICMR and WHO. Water with high dissolved solids generally are of inferior palatability.

The Dissolve Oxygen, values varied from 1.3 to 6.4 mg/l except sample S2 in other samples DO values are within permissible limits as recommended by USPH standards.

Biological oxygen Demand (BOD) values varied from 4.0 to 9.9 mg/l except S1 and S11 samples remaining samples have higher BOD values then the prescribed standards by USPH.

Water Quality Index (WQI):-

The concept of indices to represent gradation in water quality was first proposed by Horton[17] (1965). Water quality index (WQI) indicates the quality of water in terms of index number which represents overall quality of water for any intended use. It is defined as a rating reflecting the composite influence of different water quality parameters on the overall quality of water. The indices are among the most effective ways to communicate the information on water quality trends to the general public or to the policy makers and in water quality management.

The calculation of WQI was done using weighted Arithmatic Index method (Brown[30]et al. 1972) in the following steps.

Calculation of sub index (Quality Rating) Qn

Let there be n water quality parameters and quality rating or sub index (Qn) corresponding to nth parameter is a number reflecting the relative value of this parameters in the polluted water with respect to its standard permissible value. The Qn is ejaculated using the following expression.

Qn = 100[(Vn-Vio)/(Sn-Vio)]

Where Qn= quality rating for the nth water quality parameter Vn=estemated value of the nth parameter S = standards permissible value of nth at given sampling station parameter Vio = ideal value of nth parameter in pure water all the ideal values (Vio) are taken as zero for the drinking water except for pH = 7.0

Calculation of unit Weight (Wn)

The unit weights (Wn) for various water quality parameters are inversely proportional to the recommended standards for the corresponding parameters

Wn = K/Sn

Where Wn = Unit weight for nth parameters

Sn = Standard value for nth parameters

K = Constant for proportionality.

Calculation of WQI

WQI is calculated from the following equation

WQI = Σ QnWn/ Σ Wn

Water quality index is a useful method in assessing the water quality of phagi block. It's also helps to understand the quality of water of individual sampling stations in order to determine its suitability for beneficial uses. WQI values varying from 91.9962259 to 469.9506771 . All of the studied samples WQI values are very much higher than the prescribed quoted by mishra & patel. Drinking water standards recommending agencies and unit weights are shows in table no. 4 and WQI data are in table no. 5.

- **Status of water qualities based on WQI (quoted by mishra & patel 2001)**

WQI	Status
0-25	Excellent
26-50	Good
51-75	Poor
76-100	Very Poor
100 and above	Unsuitable for drinking

Conclusion :-

In the present study application of WQI gives us comparative water quality at different sampling stations. The values at all the stations except than S2 sample, are much above 100, indicating unsuitability of Phagi block water for drinking purpose. On the basis of the WQI the water sample station of S5 was found to be most polluted. It can be concluded that water quality of Phagi Block of Jaipur district (Rajasthan) is under stress of severe pollution. The water is not suitable for drinking. To save this block from further deterioration effective pollution control must be taken in the near future.

Acknowledgement :

Both of the authors Surendra Kumar Sharma and Usha Sharma are thankful to the Principal Prof.K.B.Sharma for providing the necessary laboratory facilities and also thankful to Dr, Vinay Bhardwaj (Sr.Hydrologist), S L Meena (Chief Chemist) and Dr. K.C. Sharma (Chemist) ground water department, Government of Rajasthan Jaipur for giving their valuable suggestions and possible laboratory facilities.

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