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Physico-Chemical Characteristics of Surface and Groundwater in Roorkee, Uttarakhand, India

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ABSTRACT: The impact of sewage irrigation and groundwater contamination were investigated near Roorkee in north India using the Direct Current Resistivity (DCR) method and the Radiomagnetotelluric (RMT) method. Intensive field measurements were carried out in the vicinity of a waste disposal site, which was extensively irrigated with sewage water. For comparison a profile was investigated on a reference site, where no contamination was expected. In addition to conventional 1D and 2D inversion, the measured data were interpreted using a 2D joint inversion algorithm. The inversion results from the data obtained from the sewage irrigated site indicate a decrease of resistivity up to 75% in comparison with the reference site. The depth range from 5 to 15 m is identified as a shallow unconfined aquifer and the decreased resistivities are ascribed as the influence of contamination. Furthermore, a systematic increase in the resistivities of the shallow unconfined aquifer is detected as we move away from the waste disposal site. The advantages of both, the DCR and RMT methods, are quantitatively integrated by the 2D joint inversion of both data sets and lead to a joint model, which explains both data sets.

KEYWORDS: surface, groundwater, Roorkee, Physico-chemical, characteristics, Uttarakhand

I. INTRODUCTION

Surface water is often used for the recharge of aquifers used in drinking-water production. Surface water is often contaminated with pathogenic micro-organisms and viruses. These pathogens have to be removed to produce safe drinking water. [33] Often chlorination is used as the most effective way for disinfection of drinking water. However, the use of chlorination is not permitted in the Netherlands. One effective way is the passage of surface water through soil, as is the case in bank filtration, dune recharge, and deep-well injection. Dune recharge is widely applied, where surface water, after some pretreatment, is fed into canals in protected dune sands. Then, water is abstracted after 50 to 60m of passage through the soil. [1,2]

To assure production of safe drinking water from surface water, adequate travel times and travel distances are needed. In this regard, it is important to determine various factors that affect the rate of removal of pathogenic viruses during soil passage. [31,32] These factors include hydraulic conditions (such as flow velocity and saturation) and geochemical conditions (pH, ionic strength, concentration of calcium, etc.). [3,4] In some parts of the world, use of grey water (e.g. kitchen/shower wastewater or treated wastewater) for agricultural purpose is practiced or is being considered. In such cases, it is essential to determine whether the infiltrating water will be laden with pathogenic microorganisms when it reaches groundwater. Even when water is produced from groundwater wells, it is important to have protection zones around drinking water wells in order to ensure that no pollution will reach the well. This will have achieved by enforcing a zone of protection around groundwater well. The proper determination of such a protection zone is essential. It should not be unnecessarily large as it will be costly; at the same time, it should be large enough to provide adequate protection. [5,6]

II. METHODOLOGY

Present study was carried out on the Assessment of the ground water quality of Salempur (site-1), Paniyala (site-2) and Ramnagar area (site-3) of Roorkee city. Sampling and analysis has done as per the standard methods prescribed in BIS, CPCB, APHA (2012) and Trivedy and Goel (1986). The water samples were collected from Tubewells which were located at above mentioned three sites at Roorkee in clean plastic bottles. Bottles were rinsed thoroughly 5 to 6 times

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with the distilled water before filling the water sample through grab sampling method. For the collection of Dissolved oxygen and Biological oxygen demand determination BOD bottles were used. [7,8]

Following physico-chemical parameters were analyzed as per the standard methods prescribed by APHA (1995) and Trivedy and Goel (1986).

Physico-chemical parameters: Temperature, Total Dissolve Solid, Electric Conductivity, pH, DO (Dissolved Oxygen), BOD (Biochemical Oxygen Demand), Hardness, Calcium, Magnesium, Chloride, Alkalinity, Free CO₂. [9,10]

Temperature is one of the most important factors in aquatic environment since it regulates the various Physico-chemical as well as biological activity. In present study the temperature of groundwater was found to be 19.5 °C. It was observed the value of Temperature 18.3-25.5 °C in Vuyyuru, Part of East Coast of India. [29,30] The higher TDS causes gastro-intestinal irritation to the human beings, but the prolonged intake of water with higher TDS can cause kidney stone and heart disease. The presence of high value of TDS may be due to the influence of anthropogenic sources such as domestic sewage, solid waste dumping. In the present study the maximum TDS was observed at site-2 (567.8 mg/l) and the minimum was observed at site-1 (562.5 mg/l). [34] Scholars observed the TDS value varied from 356-654 (mg/l) for groundwater. The salt concentration is generally measured by determining the Electrical Conductivity of water. Excess salt increase the osmotic pressure of the soil solutions that can result in physiological drought conditions. [35] In the present study the maximum Electrical Conductivity was observed at site-2 (847.6 µS/cm) and the minimum was observed at site 1 (841 µS/cm). Researchers observed the pH value varied from 7.55-8.78 for groundwater. Dissolved oxygen is an important parameter in water quality assessment and reflects the physical and biological process prevailing in the water, the D.O. value indicate the degree of pollution in water bodies. In the present study the D.O of ground water was found to be 3.4-3.7 (mg/l). Scientists observed the value of D.O 4.27-5.16 (mg/l). [11,12]

III. DISCUSSION

Biochemical oxygen demand is the amount of oxygen utilized by micro-organism in stabilizing the organic matter. BOD in general gives a qualitative index of organic substance which is degraded quickly in a short time period. In the present study the BOD of groundwater was found to be 0.61-0.62 (mg/l). Researchers observed the value of BOD 1.58-1.98 (mg/l). The hardness is caused primarily by the presence of cations such as Calcium and Magnesium and Anions such as Carbonates, Bicarbonates, and Chloride in water. [13,14] Water Hardness has no known adverse effects. However, some evidence indicates its role in heart diseases and hardness of 150-300 mg/l and above may cause kidney problems and stone formation. In the present study the maximum Hardness was observed at site3 (224.1 mg/l) and the minimum was observed at site 1 (221.8 mg/l). [27,28] Researchers observed the value of Total Hardness 221-474 (mg/l). Chloride is a widely distributed element in all types of rocks in 1 or other form. Chloride imparts a salty taste and sometime higher consumption cause for the development of essential hypertension, risk for stroke, renal stones and asthma in human beings. Although, the Chloride plays an important role in balancing level of electrolyte in blood plasma, but higher concentration can produce some physical disorder. In the present study the maximum Chloride was observed at site 2 (288.1s mg/l) and the minimum was observed at site-1 (286.3 mg/l). [15,16]

IV. RESULTS

Researchers observed the value of Chloride 278-347.94 (mg/l). Calcium is an important element to develop proper bone growth. Calcium content is very common in groundwater, because they are available in most of the rocks abundantly and also due to its higher solubility. The permissible limit of Calcium in groundwater is 75 mg/l. In the present study the maximum Calcium was observed at site-2 (87.1 mg/l) and the minimum was observed at site-1 (86.3 mg/l). Researchers observed the value of calcium 49.48- 81.76 (mg/l). Magnesium usually occurs in lesser concentration than Calcium due to the fact that the dissolution of Magnesium rich mineral is slow process and that of calcium is more abundant in earth's crust. If the concentration of Magnesium in ground water is more than the permissible limit, it causes unpleasant taste to the water. [25,26] Magnesium is an essential ion for functioning of cells in enzyme activation, but at higher concentration, it is considered as laxative agent, whose deficiency may cause

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structural and functional changes in human beings. The permissible limit is 30 mg/l as per BIS standards. In the present study the maximum Magnesium was observed at site-2 (49.8 mg/l) and the minimum was observed at site 3 (48.3 mg/l). Researchers observed the value of Magnesium 30-100 (mg/l). Total alkalinity values in the study area within the permissible limit and are ranging from 299.3, 299.2, 299.5 mg/l at site 1, site 2, site 3, respectively. The high alkalinity of groundwater may be due to the presence of bicarbonate and some salts. In the present study the maximum alkalinity was observed at site 2 (300.5 mg/l) and the minimum alkalinity was observed at site 3 (298.2 mg/l). Scientists observed the value of Alkalinity 308-488 (mg/l). [17,18]

V. CONCLUSIONS

The study concluded that all parameters were within the prescribed limit of IS: 10500-12 and WHO (2004). Thus, present study reveals that all parameters of site 1, site 2 and site 3 of Roorkee region are within the permissible limit. So, the groundwater of Roorkee region satisfies the water quality for drinking purpose and other uses. Groundwater is the major source of water for drinking purpose. [23,24]The groundwater is believed to be comparatively much clean and free from pollution than surface water. But pro-longed discharge of industrial effluent, domestic sewage and solid waste dump causes the groundwater to become polluted and create health problems. The problems of groundwater quality are much more acute in the areas which are densely populated, thickly industrialized and have shallow groundwater tables. The rapid growth of urban areas has further affected groundwater quality due to overexploitation of resources and improper waste disposal practices. Thus, keeping in view the above facts the present study was undertaken to analyze the physico-chemical parameters of different groundwater samples of Roorkee city. Sampling and analysis has done as per the standard method prescribed in BIS. [19,20] Water sample was collected from tube wells their location coordinates are mentioned. Analysis was carried out for various water quality parameters such as Total Dissolve Solids (TDS), Conductivity, pH, Alkalinity, Total Hardness (TH), Free CO₂, Dissolved Oxygen (DO), and Biochemical Oxygen Demand (BOD), using standard method. [21,22]

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