VOL- IX | ISSUE- IX | SEPTEMBER | 2022 | PEER REVIEW e-JOURNAL | IMPACT FACTOR 7.331 | ISSN 2349-638x

STUDY OF PHYSICO-CHEMICAL PARAMETERS AND HEAVY METAL IONS IN GROUND WATER OF SRI GANGANAGAR DISTRICT OF RAJASTHAN

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INTRODUCTION

Water is one of the major elements essential for sustenance of all forms of life and is available in abundance in nature covering approximately three fourths of the surface of the earth. The chemical nature of water is one of the most important criteria that determine its usefulness for a specific need and as such not all the waters are fit for drinking so water is conceived to be the most precious natural resource on the earth. Out of the total quantity of water present on earth, about 97% of the earth water resources are locked up in the oceans and seas which is too saline to drink and direct use in agriculture and industrial purpose, about 2% is frozen in giant glaciers and polar icecaps, remaining 1% is available for human use in the form of fresh water. Out of that 1%, 0.4% is rain water and the rest of the chunk i. e. 0.6% is ground water. The principle source from ground water recharge is monsoon precipitation in India (Mehta, 2003).

The main sources of potable water include river, lake, streams, ponds, reservoir, and springs. Another significant source of drinking water comes from ground water. Ground water is developed by three principal of aquifers. These are generally categorized as:

* Sand and gravel aquifer with in the unconsolidated geological materials overlying the bedrock.
* Shallow bedrock aquifers lying with in approximately 300 feet of land surface, and
* Deep bedrock aquifers lying at depth of land surface. It is generally consist in rock of Cambrian and Ordovician age (Wehrmann et al. , 2004).

India is a vast country having diversified geological, climatological and topological set up give rise to divergent groundwater situation in differs. Long period average rainfall over India is about 117cm; However this rainfall is highly variable both in time and space.

A major part of India's population of 1261 million with decadal growth of 21.34 percent from 1992-2001 is rural and agriculturally oriented, for whom the rivers and groundwater is the source of prosperity (Census of India, provisional population of total, General and census commissioner of India, New Delhi (2001).

Water is constantly moving along the hydrological cycle and also ground water is a part of hydrological cycle which connects with the global circulation of water. It helps to understand ground water flow in lithosphere. Water can move rapidly through the atmosphere and cover long distance from the oceans to continents. After precipitation falls it may run off to a stream or seep in to soil. Water seep in to ground may also evaporate or to be transpired by plants. The seepage may also move deeper the sub surface to recharge in aquifer.

The principle source from ground water recharge is Monsoon precipitation India. Ground water has been the domestic need of more than 80 % rural and 50 % of urban population. Around 2/5th of India's agricultural output is contributed from areas irrigated by ground water. India's gross domestic product has been estimated as about 9%.

Groundwater resources have two components Static and Dynamic, The static fresh groundwater reserve (Aquifer zone below the zone of ground water table) of the country has been estimated about 10812 b cu m. The

dynamic component is annually which has been assessed as 432 b.cu.m.the totals annual replenish able groundwater resources is about 432 b.cu.m.

The other important parameter controlling and influencing the occurrence and the movement of ground water are: landforms and cover, slope, altitude vegetation and lithology beside the metrological parameter.

Ground water usually contains negligible amount of suspended and organic impurities which get removed while passing through sand layers in earth crust. But it may contain appreciable amount of mineral impurities viz. Ca^{2+}, Mg^{+2}, K^{+}, Na^{+}, Fe^{+3}, Al^{+3}, HCO_3^{-}, CO_3^{-2}, SO_4^{-2}, Cl^{-}, NO_3^{-} finally divided clay etc. brought into solution due to disintegration of mineral deposits and insoluble carbonates or alumino-silicates rocks by the combined action of high underground temperature.

The contaminants usually found in ground water may be categorized in different categorized such as physical, inorganic, organic, microbial and radiological. Ground water pollution is usually traced back to main origins industrial, domestic, agricultural and over exploitation. Over use of contaminant effluent water not only creates anxiety to the soil health but also creates massive problem to the quality of Ground water.

The groundwater is important for the existence of human society and it is a liberal part of environment. Hence, it cannot be looked upon in isolation especially in the areas with high degree of dependence on the groundwater for drinking purpose.

Rajasthan is the largest State of the country. The status of water in the State is most critical. Rajasthan with more than 10.4 % of the country's geographical area, supporting more than 5.5% of the human population and 18.70 % of the livestock has only 1.16 % of the total surface water available in the country. 2/3rd part of the State is a part of the Great Thar Desert which is bigger than most of the states except Madhya Pradesh, Uttar Pradesh, Andhra Pradesh and Maharashtra. Out of the total 142 desert blocks in the country, 85 blocks are in the State of Rajasthan. This further aggravates the water crisis.

Rajasthan has always been a water deficit area. The rainfall is erratic and there is a large variation in the rainfall pattern in the State. Average annual rainfall of the State is 531 mm. For the 22 eastern districts, it is 688 mm whereas for the remaining western districts, the rainfall is only 318 mm. The State has witnessed frequent drought and famine conditions in the past fifty years. Ground water is not available in many parts even for drinking purpose. Sometimes water is being transported by trains, trucks and other means.

The ground water condition in Rajasthan is quite alarming. The condition has deteriorated very fast in the last two decades. Out of 237 blocks in the state, only 32 blocks are in safe category. This calls for immediate remedial measures to address the critical water resources situation the State.

Rajasthan has major share of fluoride affected villages in the country. There are 16,560 and 14,415 habitations affected with fluoride and salinity respectively. To mitigate effects of fluoride and salinity, the Government has formulated Integrated Fluorosis Mitigation Programme for providing safe drinking water to these habitations; some of these projects are under completion. Looking to the limited state resources, a sustainable source of funding for this Programme needs to be finalized to complete the Programme within Eleventh Plan.

Fluorides in drinking water may be beneficial or detrimental depending on its concentration and total amount ingested. Fluoride is beneficial especially to young children below eight years of age when present within permissible limits of 1.0 – 1.5 mg litre-1 for calcification of dental enamel. Excess fluorides in drinking water cause dental fluorosis and/or skeletal fluorosis. Indian standards for drinking water recommend an acceptable fluoride concentration of 1.0 mg F litre-1 and an allowable fluoride concentration of 1.5 mg F litre-1 in potable waters (BIS 10500, 1991). The wide occurrence of fluoride

contamination in groundwater in many unrelated geological and environmental settings seems to pose more serious problems.

Water quality monitoring involves much more than quality surveillance. It involves survey surveillance and monitoring. Survey is an exercise to have observations from a single sampling location within a stipulated period to generate qualitative and quantitative data. Surveillance involves a continuous programme of survey systematically undertaken to provide information in time and space and monitoring is surveillance undertaken to assess the progress of targets and objectives.

REVIEW OF LITERATURE

Bhatt and Hegde (1977) investigated Ground Water quality in Uttar Kannada district of Karnataka. They described that the chemical composition of most of the samples indicating as per Ground water quality prescribed by W.H.O.

Ray et al. (1981) analyzed the Ground water of rural areas near Varanasi and observed the floristic problem, even in that regions where the fluoride concentration in Ground water was under permissible limits.

Ozha et al. (1992) detected that the Western Rajasthan has some peculiar type of water and in this area problem of high nitrate and fluoride was extensively severe.

Singh (1994) investigated the temporal changes in the quality of Ground Water in Ludhiana from 1982-1993. he observed that cyanide content has increased, while trace elements content remained unchanged in ground.

Jha and Verma (2000) investigated physiochemical factors of Ground water of small Godda District of Bihar. They found that concentration of chloride, chromium and selenium was exceeding the permissible limits, which is prescribed by W.H.O. for Ground water.

Srinivas et al. (2000) assessed physio-chemical parameters of Ground Water of Hyderabad. They found that pH, So_4^{2-}, No_3^{-}, F^{-}, EC, TDS, Ca^{2+}, Mg^{2+}, Na^{+} and Cl^{-} ions concentration was below the threshold limits of Ground water as described by W.H.O.

Barik et al. (2005) monitored the trace elements assessment in Ground Water of Paradeep area, it has been observed that the concentration of Zn^{2+}, Cu^{2+}, and Mn^{2+} were below the maximum permissible limit as recommended by ISI (1983) for Ground purpose.

Harish et al. (2006) observed the status of ground water in Tarikere taluk special reference of fluoride concentration. It was estimated that Ground Water Quality in the study area was much suitable with respect of F^{-} concentration but as more than 65% of the samples have fluoride concentration, above the permissible limits.

Dutta et al. (2006) observed high fluoride contamination in Ground Water of areas having ancient alluvial red soil in Kapili-Jamuna sub-basin of central Assam have high concentration of SO_4^{2-}, much above the guideline values in some samples.

Ranjana Agrawal (2009) reported theseasonal changes of Physico-chemical parameters of Ground Water Quality of Dudu Town in Rakjasthan Comparative Studies of Samples in different seasons were conducted and it was found that the electric conductivity and total dissolved solids were decreased. Alakanity and total hardness were increased after the rainfall.

MATERIAL AND METHODS

The necessary details about the material and methods used in the present investigation are as given below:

Sampling

2 liters sample of ground water from per site were collected in polyethylene bottles, which were thoroughly cleaned before use. Samples were analyzed during the month of April, 2016 and May, 2016.

Study Areas

The ground water of Sri Ganganagar district is used for agricultural purpose as well as drinking purpose. In the present study,

fourteen sampling locations were selected, out of these sites four were selected of city and remaining was selected from Tehsils of the district. Three samples (Replicates) were taken from each location; therefore total 42 samples were collected for this study.

S.No.	Name of the location in SGNR District	Code Number
1	Kotha Pakki	S1
2	Khalsa School	S2
3	Village 9-Z	S3
4	Bus Stand Area	S4
5	CC-Head, Padampur	S5
6	Padampur	S6
7	Karanpur 60 Chack	S7
8	Gajsinghpur	S8
9	23-PS Raisinghnagar	S9
10	Raisinghnagar	S10
11	Anoopgarh	S11
12	Sri Vijay Nagar	S12
13	Suratgarh	S13
14	Hanumangarh Road (6-E-Chhoti)	S14

Table – Showing sampling sites in District Sri Ganganagar

WORK PLAN AND METHODOLOGY

Parameters

The physico-chemical parameters which will be analyzed include pH, Conductivity, Hardness, Alkalinity, Chloride, Carbonate alkalinity, Hydroxyl alkalinity and Bicarbonate alkalinity, phosphate, sulphate, sodium, potassium, turbidity, total dissolved solid and Fluoride.

Methodology

Following methods will be used to assess the quality of ground water. These methods have been summarized below-

S.No.	Parameters	Methods used
1.	Turbidity	Nephlo-metric method
2.	Electrical conductivity	Conducto-metrically
3.	pH	pH metrically
4.	Chlorides	Titration method
5.	Alkalinity	Titration method
6.	Sulphate	Spectrophotometrically
7.	Phosphate	Spectrophotometrically
8.	Sodium	Flame-photometrically
9.	Potassium	Flame-photometrically
10.	Fluoride	Ion exchange method
11.	Hardness	Titration method
12.	Total Solids	Titration method

RESULT AND DISCUSSION

Ground water quality of Sri Ganganagar showing spatial variability in different localities. The pH of ground water is almost uniform in all sampling sites and lies between 7.1 to 8.6 which is tolerable for living system as specification given by WHO and BIS.

Electrical conductance showing more variability in samples rather than pH, sampling site S_7 and S_{14} are representing maximum E.C., 8 and 8.1 respectively. High EC value in water promotes solubility of others chemical species. So sites S_7 and S_{14} are also showing high total solids value.

Spatial variability in Total Alkalinity revealing that all sampling sites are showing unequal values for Total Alkalinity. Alkalinity is major factor for biochemical reaction in living systems. Sampling site S_4, S_9 and S_{10} are showing higher value than other sampling sites. In ground water scenario. It is observed that all sampling sites are rich in carbonate and bicarbonate.

Almost all samples are transparent but sample S_7, S_9 and S_{14} are extremely, turbid due to the high amount of total solids.

Spatial variability curve of total hardness showing that sample no. S_7, S_9 and S_{14} have greater values. These values are higher than specification given by BIS 1993. Hardness

effect the aesthetic value of water. The presence of hardness reveals that water is carrying high concentration of carbonates, bicarbonates and sulphates (NEER 1999). It is also showing strong correlations with total solids (r = 0.84371) and with turbidity (r = 0.75957). It shows that geologically S_7, S_9 and S_{14} sites are rich in carbonate system.

Total hardness showing strong correlations with sulphates (r = 0.77712) its mean that permanent hardness is more abundant in all sampling sites.

Spatial variation curve of sulphate and permanent Hardness is supporting above conclusions. In geological points of view, all sampling site's lithosphere contains sulphur and sulphate compound.

Total hardness also associated with other water quality parameter such as pH with r = 0.29374, Total Alkalinity with r = 0.2974, and Phosphate with r = -0.44974, but these relations are non signification for the statistical point of view.

An interesting relationship is also observed between Total Hardness and Turbidity with value of r = 0.75957. It is good statistical relation. It may be due to the presence of sulphate species.

Spatial variability in Temporary Hardness showing that only site S_4 rich in Temporary Hardness. Site S_7 & S_8 has greater value of permanent hardness, temporary hardness (PH/PT) ratio, it is useful measure for aesthetic value of water, its unequal distribution, giving a interpretation, that sulphate & carbonate species are unevenly present in ground water of Sri Ganganagar.

Spatial distribution of Sulphate is revealing that sampling site S_3, S_6, S_7, S_9, S_{12} and S_{14} are rich in sulphate ions, which are higher than desirable limit as specified by (BIS 1993). The presence of sulphate cause permanent hardness in water, which cannot be removed by boiling of water.

Sulphate comes in ground water by weathering of rocks. Concentration of sulphate in water is showing some reasonable relationships like with turbidity (r = 0.6171) due to the insolubility of sulphate compound in water, with Total Hardness (r = 0.77712) due to the effect of permanent hardness by sulphate. A strong positive correlation is also found between total solids and sulphate (r = 0.87555) because Sulphate have bivalent charge and have a tendency to bind other metallic ions, so they increase total solid content in water.

Sulphate content is also showing some interesting relationship such as with chloride (r = 0.78057). Chemically, it is abnormal behaviour in water chemistry. Generally ions show strong correlation with their metallic ions but here chloride showing correlation with another negatively charged SO_4^{2-} ion.

Sulphate with sodium (r = 0.91149), it is much strong correlation instead of other ions. It is giving an interpretation that most of the SO_4^{2-} is, in the form of Sodium Sulphate.

Sulphate is showing a good relation with EC (r= 0.83847) because Sulphate may increase ionic mobility in water.

Sulphate is also showing some statistically non significant correlations such as with Phosphate (r = -0.37785) and with potassium (r = 0.4658).

Spatial variability in Phosphate is revealing that S_{13} & S_{12} are rich in phosphate content in ground water of Sri Ganganagar. Correlation curves between phosphate and different physicochemical properties are showing that Phosphate does not has any statistical significant correlation with different physicochemical properties like with sulphate (r = 0.37785), with electronic conductance (r = -0.18869), and with pH (r = -0.51482). It means that phosphate is not following any regular trend in ground water of Sri Ganganagar.

Spatial variability in chloride showing that sampling site S_3, S_9, S_{12}, and S_{14} are rich in chloride contents also its values are higher than Indian specification for drinking water (BIS 1993). Higher chloride value revealing that sites S_3, S_9, S_{12} and S_{14} are salt abundant rocks.

Correlation curve between Chloride & Sodium and between Chloride & Potassium showing correlation value r = 0.67406 & r = 0.64641, respectively. It is giving an

interpretation that KCI & NaCl are present in almost equal amount in ground water but Sodium is much abundant in the form of Na_2SO_4 rather than NaCl. Correlation curves of Chloride and pH is also giving some statistically non significant result (r = 0.19304).

Spatial variability in Total solids is showing that sampling site S_7 and S_{14} have higher values than specification given by BIS 1993. Total solids are also supported by concentration of carbonate, sulphate and other kind of hardness.

Total solids showing strong correlation with EC (r = 0.91569), with total hardness (r = 0.84371) and with sulphate (r = 0.87555), which have described in previous text.

Spatial variability in Sodium and Potassium are showing that site S_1, S_6, S_7, S_8, S_9, S_{12}, & S_{14} are rich in sodium content and site S_6, S_9, S_{11}, & S_{14} are rich in potassium content. Sodium and Potassium ions provide opportunity to other negatively charged radicals to bind with them. So these sampling sites are also rich in other chemical species.

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