Experimental Studies on Water Quality Analysis and Reduction of chromium at Aarang

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ABSTRACT—Groundwater is a primary source of drinking water in our country but day by day increment of groundwater contamination due to various anthropogenic activities and anthropogenic activities makes the life difficult especially for the rural people. Groundwater is getting contamination rapidly due to various anthropogenic activities as well as some natural sources. In the direction, assessment of water quality analysis is the basic requirement for nurturing human being and its evolution. Water Quality Index (WQI) parameter has been widely used in determining water quality globally. Conventional method used for computing WQI is tedious and takes longer time because it involved processing for larger datasets. The present investigation aims to provide the suitability of groundwater in the specified region using GIS (Geographic Information System) of physiochemical parameters, that are used in drinking purpose, domestic works and household chores. Locations are marked using GPS and the parameters are also used to find out about the WQI (Water Quality Index). The parameters are compared with the BIS (Bureau of India Standards) for checking the suitability of groundwater. This research also focuses on reducing the amount of chromium content in the samples, which is a heavy metal, by using organic materials. The present approach output can be beneficial to the administrators in making decisions on groundwater quality but also gaining inside into the trade of between system benefit and environment requirement.

Keywords— WQI, Area, Drinking Water Quality, Irrigation Water Quality, Groundwater Quality Assessment

I. INTRODUCTION

Understanding and determining the water quality is imperative in the study of water resources and environmental engineering. According to World Health Origination (WHO), the use of contaminated water causes around 80% of total diseases in human. Pollution in the groundwater system is a severe threat to public health as well as the economic and social life and wellbeing of the world (Milovanovic 2007).Therefore, monitoring the groundwater quality and controlling the pollution level in groundwater is the need of the hour (Simeonov et al. 2003; Simeonova et al. 3 2003). Groundwater may have direct impact to the agriculture as mostly Indian irrigation system depends on the bore well. So, it is quite essential to maintain the quality of the irrigational water also. Additionally, experts from all disciplines have approved that factor such as urbanization, industrialization, poor land organization, and environmental pollution-imposed bonus stress on irrigation production. These factors have a significant effect in terms of both quantity and quality of water for irrigation. The sufficient quantity and appropriate quality of freshwater is one of the very basic requirements for sustaining human life and civilization. The miraculous achievement of science and technology has increased the rate of utilization of groundwater for domestic, industrial and irrigation purposes multiple folds throughout the world over the last few decades. Excessive use of chemicals and pesticides for agricultural purpose often results in leaching and mixing into the groundwater. The water quality essentially determines the usability of water from some source in terms of the nature and concentration of the impurities present in the sample(Islam et al., 2011). As a combined effect of continuous deterioration in water quality and quantity, around a billion populations across the globe faces a shortage of adequate and safe water supply.

The study area Aarang, also known as "The town of temples" of Chhattisgarh, is a block and a Nagar Palika in Raipur District in the state of Chhattisgarh, India. It is situated near the eastern limits of Raipur City and close to Mahasamund City. As of 2001 India census, Aarang had a population of 16,593. Males constituted 51% of the population and females 49%. Aarang had an average literacy rate of 64%, higher than the national average of 59.5%; with 60% of the males and 40% of females' literate. 16% of the population is under 6 years of age. According to the Köppen-Geiger classification, Aarang has a Temperate or subtropical hot summer climate with nomenclature as Cwa(Monsoon Influenced humid subtropical Climate). The average annual rainfall is 589 millimetres (23.2 in) with July and August recording the maximum. The average temperature is 22.2 °C (72.0 °F) with a maximum of 40.9 °C (105.6 °F) and a minimum of 3 °C (37 °F). June is the hottest month of the year with average temperature of 33.1 °C (91.6 °F) and January recording the lowest. Economic activity is in the form of small-scale industries of rice and pulses mills. It is a commercial town where various types of forest products are marketed in Earlier Days. Geographic Information System (GIS) is a system that creates, manages, analyzes, and maps all types of data. GIS connects data to a map, integrating location data (where things are) with all types of descriptive information. A geographic information system (GIS) is a computer system for capturing, storing, checking, and displaying data related to positions on Earth's surface. GIS can show many different kinds of data on one map, such as streets, buildings, and vegetation. A geographic information system (GIS) is a computer system for capturing, storing, checking, and displaying data related to positions on Earth's surface. BIS (Bureau of India Standards), in the present stuff, the sample collected and the values obtained and compared with the BIS (Bureau of Indian Standards) values and the solutions given accordingly. A Water Quality Index (WQI) is a means by which water quality data is summarized for reporting to the public in a consistent manner. The parameters involved in the WQI are dissolved oxygen, pH, total dissolved solids, hardness, calcium, magnesium, total alkalinity, electrical conductivity. The numerical value is then multiplied by a weighting factor that is relative to the significance of the test to water quality. A Water Quality Index (WQI) is a means by which water quality data is summarized for reporting to the public in a consistent manner.

Eight common heavy metals are discussed in this brief: arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver. These are all naturally occurring substances which are often present in the environment at low levels. Working in or living near an industrial site which utilizes these metals and their compounds increases ones risk of exposure, as does living near a site where these metals have been improperly disposed. Chromium is found in rocks, animals, plants, and soil and can be a liquid, solid, or gas. Chromium compounds bind to soil and are not likely to migrate to ground water but, they are very persistent in sediments in water. Health effects Chromium (VI) compounds are toxins and known human carcinogens, whereas Chromium (III) is an essential nutrient. ● Breathing high levels can cause irritation to the lining of the nose; nose ulcers; runny nose; and breathing problems, such as asthma, cough, shortness of f breath, or wheezing. ● Skin contact can cause skin ulcers.

II. MATERIALS USED AND METHODOLOGY

A. Study Area

The command area was the area under study, it is situated within 81°45′–81°50′ E and 21°20′– 21°25′ N in the upper Mahanadi River valley (south-eastern part) and comes under Raipur district of Chhattisgarh, India. A total of ten villages, namely, Pauni, Amlitalab, Khauna, Deogaon, Bangoli, Dhansuli, Kurra, Baraonda, Saragaon and Nilja, falls under the study area, which has a tropical wet and dry climate. The temperature in this part of India remains moderate throughout the year. The highest temperatures in the year are observed as 48° between March to June. The maximum rainfall recorded is around 325mm. The average depth of the groundwater table is a minimum of 0.33 m below ground level (bgl) and a maximum of 17.14mgbl. The study area Arang, also known as "The town of temples" of Chhattisgarh, is a block and a Nagar Palika in Raipur District in the state of Chhattisgarh, India. It is part of Mahanadi Basin which is situated between latitudes 21°27'20''N and 21°4'37''N and longitudes 81°42'58''E and 81°11'49''E with a geographical area of approximately 905.79 sq.km. The minimum and maximum temperatures observed in winter (5°C) and in the summer season (48°C), with average annual rainfall 1260 mm/year. 83% of the area is agricultural land and paddy is the main crop. Except during the monsoon period, irrigation practices are common in the study area. Approximately 76% of the total cultivable area is irrigated through groundwater and surface water sources (District Census Handbo`ok, 2011). A major portion of groundwater consumption is mainly for fulfilling the agricultural and domestic needs (CGWB, 2013). The current study area is potentially susceptible in terms of groundwater pollution mainly due to anthropogenic activities (Singha et al., 2019). The groundwater samples from open and bore wells (36 sites) are collected which are extensively used for household chores and domestic purposes in the command area. The identification of the sampling points is performed using topographic sheets and GPS and the maps are prepared using QGIS 3.30.3. Topographic sheets are utilized for the preparation of base map and to recognize the general features of the area. GPS technique is utilized to identify the geographic position of each sampling point. Locations of the sampling stations and their latitudes and longitudes are presented below-

Table-1: Sample collection points

Place	Sample No.	Latitude	Longitude
Saragaon	1	81.8282	21.3761
Saragaon	2	81.8023	21.3764
Saragaon	3	81.8077	21.371
Saragaon	4	81.7961	21.3815
Saragaon	5	81.8028	21.3801
Nilija	6	81.7961	21.3815

Bangoli	7	81.8391	21.4107
Bangoli	8	81.8353	21.4134
Bangoli	9	81.8371	21.4103
Kurra	10	81.8383	21.4010
Baronda	11	81.842	21.3943
Bangoli	12	81.8433	21.4002
Baronda	13	81.8367	21.3994
Baronda	14	81.8373	21.3977
Kurra	15	81.834	21.4001
Saragaon	16	81.828	21.3760
Saragaon	17	81.8258	21.3736
Saragaon	18	81.8282	21.3761
Pauni	19	81.7824	21.3942
Pauni	20	81.7807	21.3896
Pauni	21	81.7837	21.3985
Pauni	22	81.7837	21.4066
Khauna	23	81.8001	21.4089
Khauna	24	81.8056	21.4119
Deogaon	25	81.8155	21.4273
Amlitalab	26	81.8124	21.4226
Deogaon	27	81.8152	21.4252
Bangoli	28	81.8584	21.4041
Dhansuli	29	81.8377	21.4311
Bangoli	30	81.8566	21.4033
Khauna	31	81.8001	21.4089
Bangoli	32	81.8426	21.4000
Baronda	33	81.8405	21.3729
Dhansuli	34	81.8384	21.4329
Dhansuli	35	81.8384	21.4325
Amlitalab	36	81.819	21.4177

B. Geographic Information System (GIS)

A Geographic Information System (GIS Software) is designed to store, retrieve, manage, display, and analyze all types of geographic and spatial data. GIS software lets you produce maps and other graphic displays of geographic information for analysis and presentation. A Geographic Information System (GIS) combines the visual elements and features on a map with the ability to link characteristics about these features in databases.

C. Water Quality Index (WQI)

Parameters considered for the evaluation are then compared with WQI classification of water parameters. Contributions of rest of the parameters on overall water quality are much less compared to these parameters. To calculate the WQI, a random weight (wi) between 1 to 4 is assigned to each parameter with reference to their comparative significance in general water quality. In case of the present samples, the highest weigh (4) is assigned to Cr and the lowest (1) is assigned to EC.

D. Experimental Procedure for Chromium Reduction

Since agriculture is the prime work in the selected aeras hence the use of fertilizer and pesticides are common and they also add to the increase of harmful element by leaching from topsoil and rocks is the most important natural source of chromium entry into bodies of water. Chromium primarily occurs from chromate production, stainless steel production and welding, chromium plating, ferrochrome alloys, and chrome pigment production.

1. Preparation of Adsorbent Fruit peels were washed several times to remove dirt and other impurities, then dried for 24 hours into oven at a temperature of 105˚C to remove the moisture content. Banana peels and orange peels. Collection of fruit peels Segregation and washing of fruit peels De-watering of fruit peels at 105˚C for 24 hours Carbonization at 400˚C for 30 minutes after addition of phospharic acid Activated carbon preparation at 800˚C for 10 miutes in muffle furnace.

2. Making of activated carbon from Fruit peels (Carbonization process) The material was soaked in 30% solution of phosphoric acid for 24 hours. After saturation, the liquid portion was drawn off and then dried. The dried mass was subjected to carbonization process at 400˚C, powdered well and finally activated at 800˚C for 10 minutes. After the processes of de-hydration and carbonization fruit peels were grinded into electric grinder to make it into powder form which was called as adsorbent. Figure the complete process of preparation of adsorbent from the fruit peels. The maximum removal of chromium was obtained at 1.5 g except for banana adsorbent, which was maximum 68% at 1 g, and the maximum removal of chromium from orange adsorbent was 55%.

3. Batch Adsorption Experiment This experimental work was carried out in the batch study, in which different samples were taken in conical flasks to measure the adsorption capacity of the adsorbent. 100 ml samples of domestic borewell water were taken with 1.0g and 1.5g of banana and orange adsorbents and were shacked for 30 min. After shaking, the samples were filtered with Whatman filter paper No.42 to separate the adsorbent and water sample; then the sample was stored to analyze the different physio-chemical parameters before and after the adsorbent used.

4. Adsorbent Dosage The study was carried out at different dosages of fruit peels adsorbent to get the maximum removal efficiency of physicochemical parameters removal which were present in domestic borewell water. The dosage of banana and orange peels in this study were taken as 1g and 1.5g, and water sample of 100ml in conical flask was taken and these flasks were shaken for 1 hour at a 25˚C temperature (Mosquera-Vivas C. et al).

5. Calculation for percentage removal of chromium For measuring the percentage change obtained in the sample when the adsorbents (banana and orange peels) were nixed can be calculated using the following equation: % removal = (CO-CC)/(CO) (4) Where, CO is the original observed value obtained from experiment, and CC is the reading obtained after adding the adsorbent to the sample to reduce the chromium content in the water.

III. RESULTS AND DISCUSSIONS .

A. Obtained Values of Groundwater Suitability for Household chores and Domestic Purposes

Table:2- Obtained values of Chromium

Sample no	Chromium
1	0.09
2	0.010
3	0.009
4	0.011
5	0.008
6	0.002
7	0.008

8	0.10
9	0.002
10	0.002
11	0.003
12	0.15
13	0.20
14	0.19
15	0.79
16	0.10
17	0.14
18	0.006
19	0.19
20	0.006
21	0.18
22	0.006
23	0.78
24	0.79
25	0.86
26	0.23
27	0.61
28	0.45
29	0.0079
30	0.15
31	0.7
32	0.18
33	0.08
34	0.006
35	0.19
36	0.63

B. Water Quality Index (WQI)

For analyzing the overall quality of the water, WQI is calculated. The following calculation has been made for obtaining the values of WQI index. WQI index talks about the overall quality of water. For the calculation of WQI, weight is assigned to each parameter, then relative weight is calculated and quality rating is given to each sample then WQI is calculated using the following formula,

$$WQI = \frac{\sum_{i=1}^{i=n} W_i \times q_i}{\sum_{i=1}^{i=n} W_i}.$$

Table-3: Calculated values of WQI of Chromium

S. N.	Chromium (Cr)
1	12.2
2	1.3
3	1.2
4	1.4
5	1.0
6	0.2
7	1.0
8	13.5
9	0.2
10	0.2
11	0.4
12	20.3
13	27.1
14	25.7
15	107.1
16	13.5
17	18.9
18	0.8

19	25.7
20	0.8
21	24.4
22	0.8
23	106.8
24	108.1
25	119.6
26	31.2
27	84.7
28	61.0
29	1.0
30	20.3
31	94.9
32	24.4
33	10.8
34	0.8
35	25.7
36	87.4

C. Values obtained from chromium reduction experiment

Sample no. 15,23,24,25,27,29,36 was exceeding the limit (0.007-0.737), these samples were treated with the adsorbate prepared and the following results were obtained-

It can be concluded that on using 1 gm of banana peel adsorbent the removal of chromium is maximum and on using 1.5 gm of banana peel adsorbent the removal is less as compared to the 1 gm adsorbent. The average value obtained for 1 gm of adsorbent is 67.77% and that for 1.5 gm of adsorbent the average value obtained is 55.09% which is less as compared to the 1 gm dosage of banana peel adsorbent. Also, when 1 gm of orange peel adsorbent is been used the reduction of chromium content in water is less as compared to the content reduction of chromium in water when 1.5 gm of orange peel adsorbent was used. The results were nearly same when different quantity of orange peel adsorbents was used. The average percentage change observed when 1 gm orange peel adsorbent is used is 47.52%. the average percentage change observed when 1.5 gm orange peel adsorbent is used is 51.71%. It can also be concluded from the obtained results that on using banana peel adsorbents and orange peel adsorbents gives satisfactory reduction and removal of chromium content in water. After the treatment of chromium, the water is suitable for use in household chores and domestic uses as it is now under the range as prescribed by Bureau of Indian standards.

IV. CONCLUSION AND FUTURE SCOPE

A. Conclusions-

The experiment offers a map of physio-chemical parameters and treatment for chromium. This represents the latest water quality which is been used for household chores and domestic purposes. In this study use of GIS software has been done which is used for mapping. In the study it has been found that chromium was the parameter which has maximum samples which were out of range and an experiment has been done to reduce chromium content levels in water. The following findings were discovered:

1. The study provides significant information regarding ground water quality in parts of command area.
2. As per the classification based on TDS, 91.5% parentage of samples are moderately hard, based on chlorine 94.5% water is Brackish salt.
3. In 36 samples, 11 samples of electrical conductivity accurate the range that is prescribed BIS and this increase in values of electrical conductivity indicates that salinity and temperature are increased as when salinity and temperature increase the conductivity also increases which has a negative effect on the quality of water, this is because the higher the conductivity the higher number of impurities (dissolved substances chemicals, minerals) are in the water.
4. Among the 36 samples, 1 sample of pH of water is out of range the value of the sample is 8.51 and when the pH of water becomes greater than 8.5 the water test can become more bitter and this can lead to calcium and magnesium carbonate building up in the pipes, this value of PH can cause skin to become dry, itchy and irritated.
5. The values of TDS amongst the 36 samples were found to be satisfactory, all the samples were in the range between 250 to 600 and this range is good for use of water for domestic purposes and household chores.
6. All the samples of alkalinity were in range, hands safe for domestic purpose and household works.

7. All the samples of chloride were in range and good for use household chores and domestic purposes.
8. All the samples of calcium and magnesium were in range and the water is good and safe for used in domestic purposes and household works.
9. All the samples of potassium, nitrate, sulphate, bicarbonate, fluoride are in rains and hence they are safe for use in household works and domestic purposes.
10. All the 36 samples 1 sample of iron was found to be out of range, the value was not too high, hence safe for domestic use.
11. All the 36 samples of total hardness were in range hence can we used for domestic purpose and household works.
12. In a total of 36 samples 17 samples of chromium were out of range, chromium exposure can cause skin and eye irritation.
13. Out of the 36 samples, a total of 13 water samples were of excellent quality having WQI ranging between 0-50, 19 samples have good quality with WQI index ranging between 50.1-100 and 4 samples holds poor quality of water ranging between 100.1-200.
14. Among the four different dosages of adsorbent's prepared from banana peel and orange peel banana peel showed the best result when 1 g of it was used with the water sample, hands banana peel is effective in reducing chromium content in water sample up to 67%.
15. When 1 gram of orange peel adsorbent was used with the water sample it gives the least percentage change in the chromium content of the water sample.

It can be hence concluded that the overall quality of the area is good. Due to the usage of pesticides in the area, since the area there is presence of heavy metals like chromium in water. To reduce the chromium content in water banana peel gives better result as compared to the orange peel adsorbents. nutrient management practices and regular monitoring of soil health to increase yields.

B. **Future Scope-**

1. GIS maps can be made for analysis of the water parameters and to work on the same for future analysis and improvements.
2. Adsorption isotherm can also be made for analysis of chromium.
3. GIS maps can be plotted for biological and chemical parameters as well.

4. Different studies can be made using these maps, for further investigation.
5. Improvements can be made using these maps.
6. The overall quality of water can be tracked for making improvements.
7. More organic materials such as apple peels, pineapple peels, mango peels etc. can be used for reducing the chromium content in water.
8. Improvements in the banana peel and orange peel absorbents can be made for better results.
9. Vegetable peels can also be used for removal of heavy metals.
10. An in-depth study can be made for removal of heavy metals from water.
11. GIS maps can be made for more areas and villages and different parameters can be studied.
12. Different industrial and agriculture studies can be made for better understanding of water parameters that are present in it.
13. Experiments can also be done to reduce the level of electrical conductivity in water.
14. Improvements can be made to reduce iron content in water.
15. The experiments for the parameters can be performed in monsoon and winter season.
16. Observed values of parameters obtained in different seasons can be compared.
17. Experiment for chemical parameters like coliform, e-coli, etc. can also be done during different seasons.
18. Reason for the increased chromium content in the sample can be done.
19. Investigation for the increased electrical conductivity content can be done.

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