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ANALYSIS OF GROUND WATER FOR SUSTANABLE DEVELOPMENT IN BASTER DISTRICT, CHHATISGARH: A REVIEW

Mrs Purnima Saroj*, Dr. Pratibha S. Kurup

Deparment of Chemistry,Bharti University,Durg

purnimasaroj13@gmail.com, pratibha26in@gmail.com

ABSTRACT-

Water is at the core of sustainable development and is critical for socio-economic development, healthy ecosystems and for human survival itself. It is vital for reducing the global burden of disease and improving the health, welfare and productivity of populations. Groundwater is the principal and fundamental wellspring of savoring water to townships and furthermore in the greater part of the towns. In this way, pollution of groundwater is taken as a factor of genuine misery. Groundwater is used for agriculture, household and other water needs. The reason for water contamination is misuse of water and release of untreated waste water to water resources .Groundwater contamination can happen from landfills, release from wastewater treatment plants, spilling sewers, on location sanitation frameworks, petroleum fillings stations or because of the use of manures in farming. The impact of groundwater contamination is enormous. The fundamental extreme impact of water contamination is that causing of infectious sickness in people. Reducing water use through waterless toilets, water efficient appliances, and water quantity monitoring, is an important part of sustainability for domestic water supply. Efficient piping systems that are leak-free and well insulated provide a network that is reliable and help to limit water waste.

Keywords: Ground water, sustainable development, wastewater treatment plants

Introduction-

Groundwater level is depleting fast and there has been a significant increase in chemical contamination of fluoride, arsenic, iron, and other heavy metals. The basic idea behind review paper is to find the previous work done in the current topic and to find out possible solution for the existing Problem. The use of dirty groundwater makes general wellbeing to go through harmful activities and spreading of infection. The percolation of water and its dissipation inside aquifer broadens the contaminant level. The examination of groundwater contamination for

sustainable development may focus on soil highlights, hydrogeology, hydrology, site topography and furthermore the character of the contaminants. In India it is anticipated that 33% of the people use groundwater for drinking reason. Therefore, water quality issues and its administration choices are to be given expanded consideration. Water quality is influenced by anthropogenic and characteristic impacts comprising, geography, nearby atmosphere, and water system rehearses (Deshmukh and Aher, 2016). The fast developments of urbanization and industrialization have made negative effects on the earth essentially on groundwater.

LITERATURE REVIEW

Mayank Singh et al.(2022) explained The elevated levels of uranium found in 17 states of India is alarming due to the radionuclide contamination in groundwater. Chronic ingestion can cause potential harm to humans and living things such as damage to kidneys, and cancer of the liver, lungs, and bones. The present study was undertaken to assess groundwater quality using a multivariate approach to the non-carcinogenic exposure of uranium by residents of the Bastar district, Chhattisgarh. The concentration of uranium in groundwater samples ranged from 0.50–26.4 µg/l in 70 samples, with 82% of samples being beyond the recommended limits by the International Commission on Radiological Protection. Hierarchical cluster analysis divided all sampling locations into 10 clusters explaining the similarity of geological conditions. Factor analysis extracted four principal components or factors with 70.20% cumulative variance from the entire data set. Chronic daily intake has been found above from the reference dose as 34.29, 42.86, and 51.43% for young children, children and adults. The results of hazard quotient analysis classified the degree of noncarcinogenic risk which was .1 in 34.28, 45.71, and 41.43% for the samples from young children, children and adults, respectively. This study will generate baseline data and suggest the need for revision of water quality monitoring plans and preventive water management practices. Key words: chronic daily intake, cluster analysis, factor analysis, hazard quotient, risk assessment.

Shamsh Pervez a,et al,(2020) in their paper examined the Concentrations of trace elements (Al, B, As, Be, Cd, Ba, Co, Cu, Fe, Cr, Sb, Ni, Li, Sn, Mn, Zn, V and Se) were determined in 160 groundwater samples, collected during pre-monsoon (PRM) and post-monsoon (POM) period (2017) in the tribal belt of Bastar, central India, using inductive coupled plasma mass spectrometry (ICP-MS). The concentrations of Al, As, Fe, Mn and Ni were found exceeding the permissible limits in 49% of samples. Cd, Sn and Se elements have shown two-fold increment in POM samples than those collected during PRM. On the contrary, Al, Ba, Co, Cr

and Fe have shown a declining trend from PRM to POM period. On applying Principal component analysis (PCA) and Positive matrix factorization (PMF) approaches to the dataset, observed three primary sources (natural, geogenic and agricultural) for groundwater elemental components. Among the measured potentially toxic elements (PTEs), As has shown higher carcinogenic and non-carcinogenic risk in children as well as adults This study recommends the regular monitoring of heavy metal contamination of groundwater as various geogenic and anthropogenic activities may elevate the risk of severe health hazards.

This study reports the spatiotemporal variability, source apportionment, and health risk assessment of trace and toxic elements, including heavy metals, ions, and metalloids in the groundwater of the tribal belt of the Bastar region. The concentration of Al, As, Fe, Mn, and Ni were significantly higher than the permissible limit in the groundwater of the study area in both PRM and POM. Source apportionment result of PCA and PMF shows that Natural, geogenic, and agricultural sources contributed to the groundwater chemical contaminants in the study area. The exposure risk model has shown that all elements were under a safe limit except for As, which has shown higher carcinogenic and noncarcinogenic risk values. Result predicts that prolonged exposure to arsenic through contaminated water may cause carcinogenic or noncarcinogenic risks among the inhabitants of the study area. It is noteworthy that children were more susceptible to the carcinogenic and noncarcinogenic risk as compared to adults. Hence, a conclusion can be drawn that the overall groundwater of the field area is appropriate for both drinking except for some locations where concentrations of some trace elements, especially As are higher and require proper groundwater treatment. Very few works have been done in the Bastar region on groundwater quality. Thus, this study would provide detailed knowledge so that policymakers would take proper steps to improve the water quality of the Bastar region. Further awareness among the people regarding the harmful health impacts resulting from toxic elements in groundwater is desired.

Keerti Kumar, at el, (2019), in their paper stated that Study was carried out the trend of groundwater status for 11 districts of Bastar plateau and Northern hill zone of Chhattisgarh. Long term groundwater level data of 27 years (1993-2019) were collected from Central Ground Water Board, Raipur (Chhattisgarh). The trend analysis of ground water level was computed with the help of Mann-Kendall method and linear trend graph method. Results were revealed that outcome of trend analysis of ground water level indicates that five districts reported significantly increasing trend of ground water at 1% level of significance i.e. Sukma, Bijapur,

Jashpur, Surguja and Balrampur district whereas Kondagaon and Surajpur district showed significant increasing trend at 10% level of significance. Remaining four districts the depth of ground water level was increasing but observed it was non-significant. i.e. Koria district while Bastar, Dantewada and Narayanpur districts. The status of ground water level in most of the districts i.e. Sukma, Bijapur, Kondagaon, Jashpur, Surguja, Balrampur and Surajpur recorded significantly increasing trend of groundwater level mean ground water level was going down. Keywords: Trend analysis, groundwater depth, Bastar plateau, northern hill zone, Mann-Kendall and linear trend graph method. Most of the districts of Bastar plateau and Northern hill zone of different districts the groundwater level are falling down non-significantly whereas in seven districts they are Sukma, Bijapur, Kondagaon, Jashpur, Surguja, Balrampur and Surajpur the ground water level was increasing significantly which required immediate attention.

Pooja Gupta,et al,(2018),explained that Jagdalpur city is located in the southeastern part of the Bastar district in Chhattisgarh, India. The present study is focused on hydro-chemical analysis of ground water quality around the Nagarnar where a steel plant is coming up. Nagarnar village is located between 19.0'0"N to 19.7'30"N and 82.7'30" E to 82.12'30"E longitude. The study area covers an area of 79sq.km. Hydro-climatologically, it falls within the tropical savanna type of climate region. The major source of employment in the area is agriculture industry engaging almost all of workforce. Water sample were collected from 33 stations in the month of January 2017 and were subjected to analysis for chemical characteristics. The January month was chosen as it falls nearly midway between the Pre and Post monsoon seasons. The type of water that predominated in the study area has been found to belong to CaMgHco3 type based on hydro-chemical facies. Type of water that predominates in the Nagarnar Village, Jagdalpur city Chhattisgarh area is Ca-MgHCO3 type as found for the groundwater samples of 2017 based on hydro-chemical facies. This study may be useful as a reference in the future impact assessment studies.

Princy Dugga , et al, (2019)This study illustrates the spatiotemporal variability pattern and source-routes of major ionic contaminants of groundwater in mineral-rich tribal belt of Bastar, India. Around 160 groundwater samples from 95 sampling sites were collected during the pre- and post-monsoon periods using a pooled study design. These samples were then chemically analyzed for pH, TDS, EC, TH, Mg2þ, Ca2þ, Naþ, Kþ, HCO3. The fundamental objective of the present work was to analyze the groundwater chemistry of the tribal belt area of Bastar, India, as well as to recognize the potential sources of contamination and their contribution. The

physiochemical properties show that groundwater in the field area was slightly acidic to mildly alkaline. In groundwater samples, the dominance order of cations and anions was found to follow Naþ >Ca2þ>Mg2þ > Kþ and HCO3 > Cl > NO3 > SO4 > F respectively. In the field area, a few regions showed higher concentrations of HCO3 F , NO3 than their corresponding permissible limits. The piper diagram discloses that most of the groundwater samples fall in the Ca_HCO3 water type in both PRM and POM periods. The concentration of alkaline earth metals (Ca2þþMg2þ) in most of the samples exceeded the alkali metal (NaþþKþ) concentration.Few regions in the field area require groundwater treatment for higher levels of F and NO3 Nevertheless, for improvement of water both quantitatively and qualitatively over–exploitation of groundwater should be regulated and rainwater harvesting should be implemented for artificial recharge.

Bhagirathi Behera,et al,(2017) The paper presents studies regarding the pollution of the groundwater in Jagadalpur. The water quality parameters viz pH, electrical conductivity(EC),Turbidity, Total dissolved salt (TDS), Sodium(Na), potassium(K), calcium(Ca), chloride(Cl), sulphate(SO4 -2), Carbonate(CO3), Bicarbonate (HCO3),fluoride (F-),Total hardness(TH),dissolved oxygen(DO), iron(Fe) were analysed. The result shows that the ground water from some sampling sites is within permissible limit according WHO. Keywords: Ground water, Quality of water, Jagdalpur, WHO.The ground water samples collected from the various places in and around Jagdalpur were analyzed for various physicochemical parameters such as pH,EC,turbidity,TDS,total hardness ,Ca hardness as CaCO3,Mg hardness as CaCO3,total alkalinity,phenolpthalein alkalinity,Cl- ,F- ,SO4 -2, Fe,COD,BOD,DO.The level of those low concentration of these ions does not have any considerable impact for this water to use for drinking and cooking purposes. According to this study, the Iron, turbidity, total Hardness, TDS value are higher than the tolerance value of the most of the places. So the hand pump attached study area should with filter based on activated alumina adsorption might be solution for filtering drinking water. Otherwise water should be filter by iron remover resin. In general this water may be boiling, cooled, filtered and used for drinking purpose.

Rubina Sahin (2017) in her paper discussed about Physico-chemical data highlight that high content of F in groundwater of study area due to dissociation, decomposition and dissolution of fluoride-bearing minerals Few physico-chemical parameters also give positive correlation with F ion dissolution. These groundwater are alkaline in pH (7.5 4-8.55), HCO3 -

concentration varies from 266-370 mg/l and F concentration from 1.6-7.68 mg/l. Presence of F bearing mineral in bedrock is not only factor but physico-chemical environment like aqueous ionic species, residence time of interaction, chemical behavior of free F ion with other cations and cations in groundwater, play key role of its dissolution. This study indicates that 82% groundwater samples have EC 940-1750 µS/cm and pH >7.8 Ionic concentration Ca 2+, HCO3 - , Cl- and Na+ in groundwater show strong positive relation with F- ion concentration. Based on the calculation and observation of F- ion variation and their analysis, conclusion comes out, high F- ion in groundwater of Bastar zone is due to geogenic factors. Fluoride- bearing minerals like Fluorite (CaF2), granitic and gneisses rocks and other minerals involve in rock-water interaction and liberate Fion into the groundwater. Physico-chemical parameters ranges as well as ratios are important during the dissolution process (pH: 7.54-8.55, EC- 940-1750 µS/cm. Cations and anions such as Na+, Cl- , Ca2+ and HCO3- are comparatively in good positive relation with

A K Dixit et al(2015),This research article deals with the study of quality of pond water. Pond water samples were collected from 27 villages of Bilaspur district, Chhattisgarh (India)in triplicate. Samples were analyzed for physico-chemical parameters including pH, electrical conductivity (EC), total dissolved solids (TDS), temperature, salinity and dissolved oxygen (DO). pH ranged from 6.50 – 9.69, Electrical Conductivity ranged from 118.7 – 206.6 µmhos/cm, TDS ranged from 165.5 – 254.8 ppm, Temperature ranged from 20.9 – 33.8°C, Salinity ranged from 5.1 – 6.9 ppt, Dissolved oxygen ranged from 2.41 – 4.8 mg/l. Correlation coefficient (r) was found significant at $p < 0.05$ level for the tasted parameters. The result of the proposed study will establish some facts about the use of water for various purposes like domestic and agriculture.From the above experimentations it has been concluded that the pH value observed in different pond water samples generally ranged from 6.5 to 8.5 which in compliance of the water quality criteria given by CPCB, New Delhi for all the categories (i.e., A to E). However, water samples of Mohra village, Parasahi village, BhimaTalab showed comparatively higher values (above 9) indicating that the water from these ponds are not suitable for drinking, bathing, propagation of wildlife and fisheries, and irrigation purposes. Based on the DO values measured at different ponds, it seems that most of them fell in the B or C category of water quality criteria indicating that water is safe for organized bathing and even drinking after conventional treatment

A.Khan et al(2020),The quality and quantity of drinking water have received considerable attention recently. Moreover in India, almost 70% of surface and underground water reservoirs have been contaminated by biological, inorganic and organic pollutants. Hence, the present study was conducted to characterize the physiochemical parameters (nature) of ground water in municipal areas of Purnea district town by taking water samples from five selected points (station). The assessed parameters in potable water as prescribed by different agencies (viz. – BIS ,ISI ,WHO & etc) .The Study reveals that the domestic sewage discharge and improper location of bore wells with respect to the septic tank and sewer pipes will increase the potential threat to the potable water quality.

Kurup P. (2014), this paper presents the effect of surfactant on the physiochemical analysis of waste water. Eight different locations were selected for the study and compared. The parameters studied were pH, total alkalinity, total hardness, total dissolved solids, conductivity, Acidity, free carbon dioxide, metal analyzed are Calcium, Magnesium, Copper , Nickel , Iron. From overall analysis, it was observed that the physico-chemical parameters of the waste water samples studied with the addition of surfactant showed remarkable changes. Metal analysis showed reduction in data which clearly shows that metal formed complexes with surfactant assemblies and surfactants can be used for metal detection.Corelation analysis was also carried out.

K.K. Kashyap et al,(2021) In this research we report comprehensive data from the Korba district of Chhattisgarh that has been obtained and examined. The plurality of the reports discussed uranium concentration testing in groundwater samples. Fission-track technique, ICPMS, laser fluorimetry and LED fluorimetry were used to collect the majority of the data reported. Uranium concentration in groundwater samples collected from various sites of my research region was investigated using an LED Fluorimeter. During the month of May 2021, uranium concentrations range from 0.031 µg/l to 140.10 µg/l. The concentration of uranium in 30 samples of groundwater in the Korba district of Chhattisgarh, as well as the corresponding ADD, excess lifetime cancer risk, and HQ, were determined. Uranium concentrations in 33.33% of the samples were found to be greater than the WHO and USEPA-established Maximum Contaminant Level (MCL) of 30 µg/l. Katghora1 has an HQ value of 2.52, suggesting a high risk of chemical toxicity. In this research article which focuses on uranium concentrations in different locations of groundwater samples in Korba district of Chhattisgarh.

During the month of May 2021, Uranium concentration in water samples in the study area ranged from 0.031to 140.10 µg/l.

This study reports the spatiotemporal variability, source apportionment, and health risk assessment of trace and toxic elements, including heavy metals, ions, and metalloids in the groundwater of the tribal belt of the Bastar region. The concentration of Al, As, Fe, Mn, and Ni were significantly higher than the permissible limit in the groundwater of the study area in both PRM and POM. Source apportionment result of PCA and PMF shows that Natural, geogenic, and agricultural sources contributed to the groundwater chemical contaminants in the study area. The exposure risk model has shown that all elements were under a safe limit except for As, which has shown higher carcinogenic and noncarcinogenic risk values. Result predicts that prolonged exposure to arsenic through contaminated water may cause carcinogenic or noncarcinogenic risks among the inhabitants of the study area. It is noteworthy that children were more susceptible to the carcinogenic and noncarcinogenic risk as compared to adults. Hence, a conclusion can be drawn that the overall groundwater of the field area is appropriate for both drinking except for some locations where concentrations of some trace elements, especially As are higher and require proper groundwater treatment.

Lazhar Belkhiri et al(2015) Explained Multivariate statistical analysis, geostatistical techniques and structural equation modeling were used to determine the main factors and mechanisms controlling the spatial variation of groundwater quality in the Ain Azel plain, Algeria. Cluster analysis grouped the sampling wells into two statistically significant clusters based on similarities of groundwater quality characteristics. Principal component and factor analyses (PCA/ FA) revealed that two factors explained around 85 % of the total variance, which water-rock interaction and anthropogenic impact as the dominant factors affecting the groundwater quality. The distribution of factor score one represents high loading for EC, Ca, Mg, Na, K, and SO4 in the western side and south eastern side of the plain, where water-rock interactions are dominate factors influence groundwater quality. Spatial distribution map of factor score 2 indicate that NO3,NO2, NH4, and COD show high concentration in central and southern side of the plain, where anthropogenic impact reduce groundwater quality. Further, one-way analysis of variance (oneway ANOVA) showed that the mean differences between cluster one and two show significantly differences for some water quality parameters including EC, Ca, Mg, Na, K, Cl, and SO4. Structural equation modeling (SEM) confirmed the finding

of multivariate analysis. This study provides a new technique of confirming exploratory data analysis using SEM in groundwater quality.

B. Behera et al.(2012),In ground water quality studies multivariate statistical techniques like Hierarchical Cluster Analysis (HCA), Principal Component Analysis (PCA), Factor Analysis (FA) and Multivariate Analysis of Variance (MANOVA) were employed to evaluate the principal factors and mechanisms governing the spatial variations and to assess source apportionment at Lawspet area in Puducherry, India. PCA/FA has made the first known factor which showed the anthropogenic impact on ground water quality and this dominant factor explained 82.79% of the total variance. The other four factors identified geogenic and hardness components. The distribution of first factor scores portray high loading for EC, TDS, Na+ and Cl− (anthropogenic) in south east and south west parts of the study area, whereas other factor scores depict high loading for HCO3−, Mg2+, Ca2+ and TH (hardness and geogenic) in the north west and south west parts of the study area. K+ and SO42− (geogenic) are dominant in south eastern direction. Further MANOVA showed that there are significant differences between ground water quality parameters. The spatial distribution maps of water quality parameters have rendered a powerful and practical visual tool for defining, interpreting, and distinguishing the anthropogenic, hardness and geogenic factors in the study area. Further the study indicated that multivariate statistical methods have successfully assessed the ground water qualitatively and spatially with a more effective step towards ground water quality management.

Kamlesh Kumar (2018) Tirathgarh Formation in the Mesoproterozoic Indravati Basin rests uncomfortably over deformed and metamorphosed Archaeanto Palaeoproterozoic basement predominantly comprised of Darba Granite. This formation is mainly siliciclastic in nature with minor argillaceous intercalations and devoid of any carbonate rock. Geochemistry of the basal part of arenites closer to the unconformity shows high SiO_2 (94.02%) content, low TiO_2 (0.06%), Al_2O_3 (3.16%), FeOT(1.34%), MgO (0.14%), MnO (0.01%),CaO (0.05%), Na_2O (0.36%), K_2O (0.68%) and P_2O_5 (0.02%) content as compared to the Upper Continental Crust (UCC).Integrated geological, radiometric and radon emanometry studies have resulted in the identification of uranium and radon anomalies while sub-surface drilling in target areas have confirmed the presence of concealed uranium mineralization (U-Cu-Zr-Cr) hosted in the basal part of Tirathgarh Formation along the unconformity. Extensive alteration due to the circulation of basinal fluids has also been observed along the mineralized zones. Possibility of

migration of such fluids along fault zones to deeper parts in the basement cannot be ruled out. Exploration for uranium in this basin has resulted in the identification of uranium mineralization in TirathgarhFormation hosted in arenite and associated with unconformity and reactivated basement faults

Vishnu Kumar singh(2022) Based on available analytical results of Five surface water samples of study area indicate that pH varies from 8.71 to 9 which shows slightly alkaline in nature andT DS is below 520 ppm. The analytical result of all samples shows total hardness under desirable limit i.e. maximum 150 ppm. All samples found to have lower alkalis values than the desirable limits i.e., K+ F, Cl Ca, Mg except Na+ it is under permissible limit. Irrigational water quality standards such as SAR, CR, RSC,% Na etc. indicates suitability of water for irrigation, which shows quality of water is excellent, safe and suitable for agriculture purpose. From the piper diagram, it is observed that, water samples collected from all quadrangles are Ca-HCO3 type and are having temporary hardness. From the analytical results of stream water, sediment and Regolith-horizon shows Th (thorium) and U (uranium) toxicity which might be the cause of kidney related disorder in the study area.

CONCLUSION

Pollution of surface and ground water resources occurs through point and non-point diffusion and degradation of water quality creates water scarcity for human use. The physiochemical properties of potable water at all sampling stations were analyzed . The results indicate that water quality of bore wells are polluted (having existing concentration of iron) is not best for domestic use. Water quality of some sites is poor and somewhat more contaminated. There are many physiological effects show on the human health such as indigestion, rheumatism, urinary infection and etc. Moreover, improper location of bore wells with respect to septic tanks and sewer pipes will increase the potential for the leaching of waste water / effluents to the ground water table. Very few works have been done in the Bastar region on groundwater quality. Thus, this study would provide detailed knowledge so that policymakers would take proper steps to improve the water quality of the Bastar region. Further awareness among the people regarding the harmful health impacts resulting from toxic elements in groundwater is desired.

REFERENCE-

1. Mayank Singh a, Pokhraj Sahub, Kavita Tapadia a,* and Dalchand Jhariya ,(2022), "ASSESSMENT OF THE GROUNDWATER QUALITY BY USING MULTIVARIATE APPROACH AND NONCARCINOGENIC RISK OF URANIUM IN THE INHABITANTS OF THE BASTAR DISTRICT, CHHATTISGARH, CENTRAL INDIA" Water Supply Vol 22 No 4, 3863 doi: 10.2166/ws.2022.024
2. Shamsh Pervez a,* , Princy Dugga a , Mohammad Nahid Siddiqui b , Shahina Bano a , Madhuri Verma a , Carla Candeias c , Archi Mishra a , Sushant Ranjan Verma a , Aishwaryashri Tamrakar a , Indrapal Karbhal a , Manas Kanti Deb a , Kamlesh Shrivas a , Yasmeen Pervez d , Rakesh Kumar Jha e,"SOURCES AND HEALTH RISK ASSESSMENT OF POTENTIALLY TOXIC ELEMENTS IN GROUNDWATER IN THE MINERAL-RICH TRIBAL BELT OF BASTAR, CENTRAL INDIA", , Department of Chemistry and IRC Membranes and Water Security, King Fahd University of Petroleum & Minerals, Dhahran, Saudi Arabia c GeoBioTec, Geosciences.
3. Keerti Kumar, GK Das, HV Puranik and Manoj Kumar Beck,(2019), "SEASONAL AND ANNUAL TREND ANALYSIS OF GROUND WATER STATUS IN DIFFERENT DISTRICTS UNDER BASTAR PLATEAU AND NORTHERN HILL ZONE OF CHHATTISGARH"
4. Pooja Gupta , Medha Jha , D. K. Deolia3 , Sanjay Tignath4, (2018)"HYDRO CHEMICAL ANALYSIS OF GROUNDWATER QUALITY AROUND JAGDALPUR, DISTRICT BASTAR, CHHATTISGARH, INDIA" International Journal of Research in Engineering, Science and Management Volume-1, Issue-11, November-2018 www.ijresm.com | ISSN (Online): 2581-5792.
5. Princy Dugga a , Shamsh Pervez a , Mamta Tripathi a , Mohammad Nahid Siddiqui,"SPATIOTEMPORAL VARIABILITY AND SOURCE APPORTIONMENT OF THE IONIC COMPONENTS OF GROUNDWATER OF A MINERAL-RICH TRIBAL BELT IN BASTAR, INDIA"
6. Bhagirathi Behera, Mira Das and G. S. Rana, "STUDIES ON GROUND WATER POLLUTION DUE TO IRON CONTENT AND WATER QUALITY IN AND AROUND, JAGDALPUR, BASTAR DISTRICT, CHATTISGARH, INDIA" Dept of Chemistry, ITER, Siksha "O" Anusandhan University, Bhubaneswar,Journal of Chemical and Pharmaceutical Research, 2012, 4(8):3803-3807 ISSN : 0975-7384 CODEN(USA) : JCPRC5

7. Rubina Sahin, (2017), "INFERRING THE CHEMICAL PARAMETERS FOR THE DISSOLUTION OF FLUORIDE IN GROUND WATER OF BASTER ZONE,CHHATTISGARH,INDIA",Research Journal of Chemical sciences Vol. 7(2), 54-59.
8. A K Dixit , S K Pandey , R Mehta , NiyazAhmad , Gunjan , JyotiPandey, (2015) "STUDY OF PHYSICO-CHEMICAL PARAMETERS OF DIFFERENT POND WATER OF BILASPUR DISTRICT, CHHATTISHGARH, INDIA", Environmental Skeptics and Critics, 4(3): 89-95
9. A.Khan , Chandrama Kumari , Alok Kumar Yadav (2020) "PHYSIO-CHEMICAL CHARACTERISTICS OF BOREWELL WATER SAMPLES OF PURNEA TOWN", International Journal of Scientific and Research Publications, Volume 10, Issue 7, July pg 860-864
10. Kurup P. (2014),"PHYSIO-CHEMICAL ANALYSIS OF WASTE WATER USING SURFACTANT ASSEMBLIES" International Journal For Innovative Research In Science & Technology (Ijirst), Volume 1 | Issue 3
11. 11.K.K. Kashyap and M. K. Ghosh, (2021)"URANIUM CONCENTRATION AND HEALTH RISHK ASSESSMENTS IN GROUNDWATER SAMPLES TAKEN DIFFERENT LOCATION OF KORBA DISTRICT, CHHATTISGARH, INDIA"Eco. Env. & Cons. 28
12. 12.L. Belkhiri et al. (2015),"USING MULTIVARIATE STATISTICAL ANALYSIS, GEOSTATISTICAL TECHNIQUES AND STRUCTURAL EQUATION MODELING TO IDENTIFY SPATIAL VARIABILITY OF GROUNDWATER QUALITY"Water Resour. Manag.Water Resour Manage (2015) 29:2073–2089
13. 13,B. Behera et al. .(2012),"STUDIES ON GROUND WATER POLLUTION DUE TO IRON CONTENT AND WATER QUALITY IN AND AROUND, JAGDALPUR, BASTAR DISTRICT, CHATTISGARH, INDIA"J. Chem. Pharmaceut. Res.
14. Kamlesh Kumar,(2018),,Rahul Banerjee 2 and Deepak B Malpe3,"GEOCHEMISTRY AND URANIUM POTENTIAL OF TIRATHGARH FORMATION,INDRAVATI BASIN, BASTAR DISTRICT, CHHATTISGARH, INDIA" Journal of Applied Geochemistry,Vol. 20, No. 4 pp. 392-398
15. Vishnu Kumarsingh,,Harsisanth S, (2022)" QUALITY ASSESSMENT OF SURFACE WATER AROUND RAJAHMUNDRY AREA AND ITS IMPLICATION ON

AGRICULTURE AND HUMAN HEALTH", Journal of Research Publication and Reviews, Vol 3, no 12, pp 227-240.