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ASSESSMENT OF WATER RESOURCES AND STATUS OF QUALITY OF GROUNDWATER IN THE STATE OF CHHATTISGARH, INDIA: A REVIEW

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ABSTRACT

Chhattisgarh state of India is rich in mineral resources. The region has large deposits of coal, iron, and bauxite. In the recent years, groundwater quality of the region has deteriorated due to industrialization, agricultural activities, mining and other anthropogenic activities. Critical review has been carried out to determine and assess the influence of mining and other industries on water quality. The aim of the review is to consolidate the information and database on groundwater resources of Chhattisgarh area, central India for evaluation and characterization of groundwater quality and thereby assessing the sustainability of safe drinking water. Present study is helpful for long term planning and management of ground water sources of the study area. It has been found that the concentration of Arsenic, Fluoride, Iron have been found to be higher than WHO permissible limits in many regions of Chhattisgarh.

KEY WORDS : Industrialization, Ground water quality, Mining

INTRODUCTION

Water is an essential and highly scarce resource for human being whose demand has always been driven by population pressure and huge demands for water in meeting various anthropogenic needs (McDonald *et al*., 2011). Water pollution occurs when harmful substances are discharged into water bodies without provision of adequate treatment for the removal of harmful compounds, and/or when there is a significant change in its ability to support its biotic communities (Ezeaku *et al*., 2012; Ascott *et al*., 2016). Both natural process and anthropogenic activities like hydrological features, climate change, precipitation, agricultural activities and wastewater discharge from industries are main reason for worsening of surface water quality (Ravichandran *et al*., 2003; Gantidis *et al*., 2007; Arain *et al*., 2008). Rapid industrialization is continuously degrading the quality of water bodies (Shannon *et al*., 2008; Qu *et al*., 2013). According to recent UN report (UN World Dev. Report 2015; Wiley-scrivener 2014) reliable access of clean and affordable water is one of the most basic humanitarian goals and is a major global challenge for 21^{st} century. The pollution caused by heavy metals is long-term, non-reversible and are not biodegradable (Mcgrath *et al*., 2000; Singh *et al*., 2006).

Many of these metals can be bio-accumulated by aquatic organisms and chances of their entrance in food-chain, causing serious health and environmental concerns even at low concentration (Trivedy *et al*., 2000). The main anthropogenic sources of heavy metal in rivers are raw waste water from industries, mining activities, sewage and agrochemicals from agriculture fields (Macklin *et al*., 2000; Martin *et al*., 2006; Reza *et al*., 2010).

Chhattisgarh is situated in the central region of India. Chhattisgarh is one of the richest Indian states in natural resources. The coal, iron ore, bauxite, abundantly occurs in northen and southern parts of the state including Bailadila (Dantewada), Dallirajhara (Balod), Sarguja, Bastar, Korba, Raigarh and Bilaspur. Coal mines and thermal power plants

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are located in Raigad and Korba region. Steel industries are located in Bhilai, Raigarh and Raipur region of Chhattisgarh. Paper industries are located in Jangir-Champa district. Due to mining, industrialization and other anthropogenic activities the quality of the available groundwater resources is being increasingly degraded.

In the present study, a critical review of the assessment of groundwater of Chhattisgarh area has been presented. Addressing the problem requires a better understanding of source and cause of pollution which will help to develop effective ways of improving the ground water quality in the study area.

STUDY AREA

Geographical Location

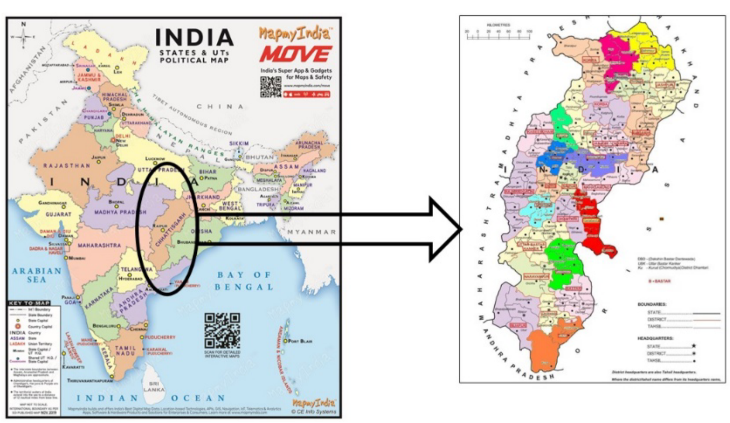
Chhattisgarh lies between $17^0 46'$ N and $80^0 20'$ E.It covers an area of 135133 km^2 of India.

Methodology

We tried to summarize data and findings of a number of research publications from 2001 to 2015 on groundwater resources in different regions of Chhattisgarh state of India. We tried to review the quality of ground water for drinking purpose and the health risks associated with it. Physico-chemical parameters needs to be ascertained to study the quality of ground water which includes pH, electrical conductivity, TDS, TH, Fluoride, sulphate, Nitrate, Carbonate, Bicarbonate, Sodium, Potassium, calcium, magnesium, fluoride and heavy metals like arsenic iron, lead.

Reported Studies

Various studies have been carried out by different researchers to assess the quality of groundwater in Chhattisgarh. The research carried out in Kourikasa, Rajnandgaon district of Chhattisgarh (Patel *et al*., 2017) and it was found out that the toxic elements arsenic and fluoride occur in several folds higher concentration than WHO permissible limits. The groundwater is strongly sodiac in nature with high WQI value. Seven districts of Chhattisgarh were surveyed for child fluorosis (Vilasrao *et al*., 2014) and it was found that 54% of handpumps had fluoride level more than recommended. Prevalence of fluorosis ranged between 12-44% in children of surveyed districts (Ambikapur, Balod, Balrampur, Bastar, Kanker, Korba and Surajpur). In Korba district, heavy metals Aluminium and iron were reported in alarming levels at sampling points (Janjal *et al*., 2010). In Dallirajhara, Balod district concentration of iron is much more than the maximum permissible limit as given by BIS and WHO (1.2-3.2 mg/l) (Biswas *et al*., 2015). Variation of iron concentration were within 0.72-6.89 mg/l in all four sites of Urla, Raipur district (Verma *et al*., 2016). High concentration of fluoride was found in post monsoon period as it ranges from 0.74-1.20 ppm in Sarguja district (Pandey *et al*., 2015). Higher concentration of ions were found in deep tube wells (fluoride, chloride, sulphate, nitrate, bicarbonate, sodium, potassium, magnesium, calcium) along with higher fluoride concentration in Dongargaonblock (Sahu *et al.,*). During the course of study of two villages Sonsaytola and Joratarai of Ambagarhchowki block, Rajnandgaon district,it was found that water is contaminated with high arsenic 0.24 and 0.210 ppm respectively (Mukherjee *et al*., 2009). The studied area of Raigarh district has shown significant presence of fluoride in the groundwater (Pandey *et al*., 2013). In Janjir-Champa district, it was observed that, EC, Turbidity, BOD, COD, Phosphate, sodium have been found higher value than maximum permissible limit of WHO



standards of drinking water (Vaishnav *et al*., 2013). Analysis of water bodies of Balco industrial area in Korba was studied (Vaishnav *et al*., 2012). The mean data for EC, Turbidity, TDS, were above desirable level but slightly lower than excessive limit. Iron and aluminium were higher in groundwater source (0.93 and 4.106 mg/l) (Vaishnav *et al*., 2012). The ground water quality of Raipur city for drinking purpose was analysed and found that ground water of some parts of Raipur city is unsuitable due to concentration of nitrate, magnesium and calcium beyond permissible limits as prescribed by BIS (2009) (Khan *et al*., 2017). In Raipur city, 22.24 % of water falls under poor category as per WQI classification for drinking purpose (Khan *et al*., 2017). Water samples were collected from five villages of Bodla block of Kabeerdham district and it was found that fluoride concentration of water samples were over the permissible limits (Upadhayay, 2014). Ground water quality of Bailadila iron ore mine area and its peripheral Dantewada district have been studied (Jareda *et al*., 2016). From the analysis it was found that EC, turbidity, magnesium, sulphate,nitrate and heavy metals such as lead ,iron are higher than permissible limit (Jareda *et al*., 2016). Hasdeo, a tributary of Mahanadi river, passes through Korba region which has been identified as fifth among polluted cities in India according to CPCB (CPCB, 2009) due to coal mines and power plants. Samples of water at four locations were collected and analysed and it was found out that most of the physical and chemical parameters exceeded the prescribed limit (Bhasker *et al*., 2015). Nearly 18% of sampled wells in Raigarh district had fluoride concentration above desirable limit (7.10 mg/l), the highest value being 8.8 mg/l (Beg *et al*., 2011). Hydrogeochemical investigation of water discharged from mines of Korba field was carried out to assess mine water geochemistry and its suitability for domestic, irrigation and industrial use (Singh *et al*., 2011). The quality assessment of drinking water indicates that TDS, total hardness and concentration of some trace metals (Fe, Mn, Ni, Al) exceeded the acceptable levels in a number of mine water samples (Singh *et al*., 2011). The iron and aluminium were reported in enormous range from 0.1 to 24.0 mg/l and .03-.28 mg/l for ground water, 0.19-10.62 mg/l and 0.14-6.93 mg/l for surface water from the samples collected from water bodies in Balco area, Korba, Chhattisgarh (Dewangan *et al*., 2010) (Table 1) (Plot-1)

Health Risk Assessment

Drinking water with fluoride content greater than 1.5 mg/l may cause fluorosis to crippling skeletal fluorosis as the level and period of exposure increase s (WHO Guidelines, 2004). About 62 million people, including six million children are at risk of fluorosis in India (Carton, 2006,). Dental and skeletal fluorosis is endemic among children in surveyed district of Chhattisgarh state (Vilasrao *et al*., 2014) and is related to drinking water with fluoride content of 1.5 ppm. Dental fluorosis was prevalent in five villages of Raigarh district-Dholnara, Kunjhemura, Muragaon, Pata and Saraitola and skeletal fluorosis was found only in Muragaon (Beg *et al*., 2011) (Table 1).

The average lethal dose of iron is 200-250 mg/kg of body weight (NRC, Baltimore, 1979). Autopsies have shown hemorrhagic necrosis and sloughing of area of mucosa in the stomach with extension into submucosa. Chronic iron overload results primarily from a genetic disorder (haemochromatosis) characterized by increased iron absorption and from disease that require frequent transfusion (Bothwell, 1979).

The common symptoms of chronic arsenic toxicity due to prolonged drinking of arsenic contaminated water are pigmentation, keratosis and cancer of skin (Guha Majumdar *et al.,* 2010). Keratosis, arsenicosis produces protein manifestations like weakness, chronic respiratory disease, peripheral neuropathy, liver fibrosis, peripheral vascular disease (Arsenic in drinking water, NRC 1999; Guha Mazumdar *et al*., 1998). In Bangladesh and India alone, 70 million people are at risk,due to exposure to high concentration of arsenic in drinking water (Niu *et al*., 2007). Several diseases like dysfunction of respiratory system, injury to nervous system, hepatomegaly, hypertension and diseases of peripheral vascular and cardiovascular system with lungs, kidney, liver, skin, bone, rectum cancer has been reported from this region (Guan *et al.,* 2012).

RESULTS AND DISCUSSION

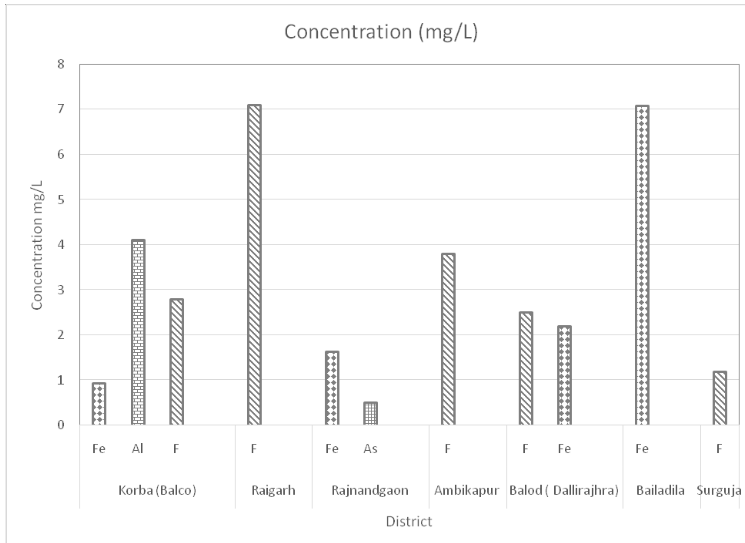
Chhattisgarh region is rich in natural resources but mining and uncontrolled anthropogenic activities have resulted in deterioration of water quality. It has been found that the Bailadila, Dallirajhara regions have high concentration of iron in ground water. Rajnandgaon district has high concentration of

Table 1. Summary of Reported Studies

S. No.	Accomplished Task	Research Location	Assessed Physico-chemical parameter	References
01	Groundwater Arsenic and Fluoride in Rajnandgaon district Chhattisgarh India	Rajnandgoan (Kaurikasa)	As, F, in drinking water	(Patel *et al.*, 2017)
02	Child Fluorosis in Chhattisgarh, India : A Community based survey	Few districts of Chhattisgarh	Fluoridev	(Vilasrao *et al.*, 2014)
03	Assessment of Heavy metals in Korba district, Chhattisgarh	Korba	Heavy metals	(Janjal *et al.*, 2010)
04	Quality of ground water of Dallirajhara area, Balod district Chhattisgarh due to min ing activities	Balod	Heavy metals (Fe)	(Biswas A *et al.*, 2015)
05	Correlation between iron pollution and physico-chemical characteristic of effluent from steel industries from Urla, Raipur, Chhattisgarh	Urla, Raipur	Heavy metals (Fe)	(Verma *et al.*, 2016)
06	Fluoride concentration in groundwater due to mining activities in parts of Chhattisgarh	Sarguja	Fluoride	(Pandey *et al.*, 2015)
07	Geogenic arsenic contamination to groundwater in parts of Ambagarh chowki block, Rajnandgaon	Ambagarhchowki Rajnandgaon	Arsenic	(Mukherjee *et al.*, 2009)
08	Fluoride mobilization due to coal mining in parts of Chhattisgarh	Raigarh District	Fluoride	(Pandey *et al.*, 2013)
09	Effect of paper-mill effluents of ground and surface water bodies of some selected areas of Janjgir-Champa, Chhattisgarh,India	Janjgir-Champa	Electrical conductivity, Total hardness BOD, COD, Phosphate, sodium	(Vaishnav *et al.*, 2013)
10	Analytical study of surface water system of Balco Industrial area in Korba, Chhattisgarh, India	Korba	Iron, Aluminium	(Vaishnav *et al.*, 2012)
11	Groundwater quality assessment for drinking purpose in Raipur, Chhattisgarh using WQI and GIS	Raipur	Magnesium, Calcium,Nitrate	(Khan *et al.*, 2017)
12	Analytical study of fluoride ion concentration in drinking water of Bodla block in Kabeerdham district, Chhattisgarh	Kabeerdham	Fluoride	(Upadhayay, 2014)
13	Water quality index and heavy metal pollution index of Bailadila iron ore mine area and its peripherals	Bailadila,Dantewada nitrate, Electrical conductivity	Iron, lead, magnesium, sulphate,	(Jareda *et al.*, 2016)
14	Water quality appraisal of Hasdeo river at Korba in Chhattisgarh, India	Korba	Physico-chemical parameters	(Bhasker, *et al.* 2015)

Table 1. Summary of Reported Studies

S. No.	Accomplished Task	Research Location	Assessed Physico-chemical parameter	References
15	High fluoride incidence in ground water and its potential health effects in parts of Raigarh district, Chhattisgarh,India	Raigarh	Fluoride	(Beg *et al.*, 2011)
16	Hydrogeochemical investigation and quality assessment of mine water resources in Korba coalfield, India	Korba	TDS, TH, Fe, Mn, Ni, Al	(Singh *et al.*, 2011)
17	Pre-Monsoon statistical analysis of physico-chemical parameters and heavy metals in different water bodies of Balco area, Korba, Chhattisgarh, India	Balco, Korba	Iron, Aluminium	(Dewangan *et al.*, 2010)



Plot 1

arsenic and fluoride. Korba region has high iron and aluminium. Raigarh has high fluoride concentration in ground water.

CONCLUSION

It is therefore an urgent need to make arrangement for availability of safe water source in the different regions of Chhattisgarh affected by arsenic,iron, aluminium and fluoride. Awareness generation and motivation of people for testing their drinking water source are also important to prevent further exposure of pollutants and heavy metal to these people. The results from the review can be utilized by the authorities and agencies for water management of the area and protective measures to prevent contamination of ground water

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