iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 8 **Issue:** VIII **Month of publication:** August 2020

DOI: https://doi.org/10.22214/ijraset.2020.31101

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue VIII Aug 2020- Available at www.ijraset.com

Impact of Industrialization on Groundwater Quality - A Case Study of Derabassi Industrial Area, Punjab

Meenakshi Tewari[1], Prof. Shakti Kumar Arora[2]
[1]*M.Tech Student,* [2]*Associate Professor, Department of Environmental Engineering, Punjab Engineering College (Deemed to be University), Chandigarh, India*

Abstract: ***Rigorous human activities have caused contamination of groundwater quality which therefore affects human health. During this research, an assessment of groundwater quality was done for evaluation of the status of groundwater contamination and latent risks to residents in the Derabassi block of district Mohali, Punjab which is also the industrial belt of the district. Groundwater samples were collected from 12 different locations within the industrial area standard analytical methods were embraced for Physico-chemical analysis and the results were compared with the Bureau of Indian Standards (BIS) guideline values for potable water The examinations uncover that most of the examination domain is highly contaminated due to the excessive concentrations of one or more water quality parameters such as Total Hardness, Calcium, Magnesium, Total dissolved solids, Sulphates, Fluorides, Nitrates, which have rendered the water samples tested, non- potable. Discussions held by the authors with the local public as well as the Primary health center authorities of the area uncovered that many individuals in the area are suffering from severe health problems on utilizing this water.***

Keywords: **Contamination, Groundwater quality, effluents**

I. INTRODUCTION

Groundwater is the most important natural resource for human survival all over the world (Wu et al. 2012). Groundwater quality, however, is deteriorating at an alarming rate due to the changing environment and intensive human activities (Li et al. 2012), which poses significant health risks to people who consume it and take baths with it. Numerous incidents of groundwater contamination have been reported in the USA (Hudak 2010), China (Han et al. 2013; Li et al. 2014a; Liu et al. 2007), India (Chidambaram et al. 2014), and many other regions of the world (e.g., Mexico, Esteller et al. 2015, and Korea, Venkatramanan et al. 2014)

Groundwater contamination is a major environmental issue. The quick pace of industrialization that has as of late become the need of great importance for a developing nation like India has transformed into a significant source of groundwater defilement. Tremendous inputs of pollutants have been taking the toxins' levels past the absorptive limit of nature. The ventures that actuate the contaminants into the groundwater assets don't carefully manage their contaminations as far as possible. Most of the industries discharge their effluents without proper treatment into nearby open pits or pass them through unlined channels, which move towards the low lying depressions on land, resulting in the contamination of groundwater (Purandara and Varadarajan 2003).

The industrial effluents if not treated and properly controlled, can pollute and cause serious damage to the groundwater resources (Olayinka 2004) The industrial growth rate in Derabassi has put a negative impact on the geological resources in the city and groundwater is primarily one such resource. With the surface water supplies being not, at this point able to satisfy the necessities of the city, groundwater turns into the main alternative source of good quality water. But there are issues of groundwater contamination in certain parts of the city, especially the industrial belts A good number of industries of different types have been established in the conurbation of Derabassi. These contaminants may enter the soil/water and degrade the quality of groundwater. Once the groundwater is polluted, it might stay in unusable or even perilous condition for quite a long time or even hundreds of years (Mishra et al. 2005).

The Central Groundwater Board carried out studies in Punjab for groundwater quality, The concentration of iron (total) in groundwater of the study area ranges from below detection limit to 25.825 mg/l in hand pump located at Isarpur village, block Derabassi in SAS Nagar district. The point values of locations with Iron above BIS permissible limit of 0.30 mg/l for drinking water depicted that 34.9% of samples have iron concentration exceeding this limit. which has been loading the environment with ever-increasing levels of pollutants. (CGWB 2016). An examination led by Punjab Agricultural University (PAU) in 2012 had said that the water was "unfit" for drinking. The villages in Dera Bassi are influenced by the sewage release from production lines, streaming into close by channels. The villagers claim that it isn't just contaminating the groundwater, and subsequently the water supply from hand pumps and tubewells, yet in addition, causing air contamination in Dera Bassi.

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue VIII Aug 2020- Available at www.ijraset.com

At the point when untreated effluents are straightforwardly discharged to land and water bodies, it conceivably contaminates soil and groundwater with harmful metals (Aryal et al., 2017; Liu et al., 2016; Yegemova et al., 2018). There are many sources of contamination but the discharge of chemical waste from industrial units is one of the major sources of surface water contamination and its pollution (Kumar et al., 2020)

At present, there are around 300 mechanical units and four meat plants here. The groundwater of Bhankerpur, Issapur, Pragpur, Lalru, Kurawala has been contaminated because of the sewage depleted from industrial facilities, because of which individuals of these towns can no longer drink water from hand pumps. Thus, the present examination targets assessing the level of pollution in the region, evaluating the degree of contamination in the territory, recognizing the risky poisons, and proposing mitigative measures.

II. MATERIAL AND METHODS

A. Study Area

Derabassi is a city in the state of Punjab having a total area of 1.098km2. Derabassi is located near the foothills of the Shivalik range of the Himalayas in northwest India. It has an average elevation of 321 meters (1053 ft). The latitude and longitude of Derabassi are 30.596403 and 76.843269 respectively. It is located near the boundary of Haryana, Himanchal Pradesh and Union Territory Of Chandigarh, The city is most famous for its industrial belt, situated for the most part on Ramgarh and Barwala Road. Derabassi has a humid subtropical climate characterized by a seasonal rhythm: very hot summers, mild winters, unreliable rainfall and great variation in temperature Derabassi experiences variation in temperature and has a humid subtropical climate The city receives winter rains from the Western Disturbance originating over the Mediterranean Sea. Mostly, the city receives heavy rain from the south but it generally receives most of its rain during monsoon either from North-west or North-east.

B. Sampling

The villages whose water quality was assessed were chosen because of their location near the industries. The sampling arrangement for this study was carried out to collect site-specific information related to the influence of industrial and agricultural activities near the sampling sites. 10 sampling sites were selected namely: Issapur, Saidmajra, Dhanauni, Derabassi Busstand, Mubarakpur, Samalheri, Bhankarpur, Bhagwanpur, and Lalru as shown in figure 1 and table 1. Global Positioning System for the selection of representative hand pumps and tubewells for groundwater sampling.

SAMPLE NUMBER	LOCATION	SOURCE
S-1	ISSAPUR	HANDPUMP
S-2	SAIDMAJRA	HANDPUMP
S-3	DHANAUNI	TUBEWELL
S-4	DERABASSI BUS STAND	HANDPUMP
S-5	BHAGAT SINGH NAGAR	TUBEWELL
S-6	BHANKARPUR	HANDPUMP
S-7	LALRU	TUBEWELL
S-8	BALLORPUR	HANDPUMP
S-9	BHAGWANPURA	TUBEWELL
S-10	SAMALHERI	TUBEWELL

Table1. Source of sample location

1) *Sampling Period:* The Groundwater samples were collected thrice a month from January 2020 to March, 2020. ten different villages were selected near industries for our study. 90 Groundwater samples were collected.

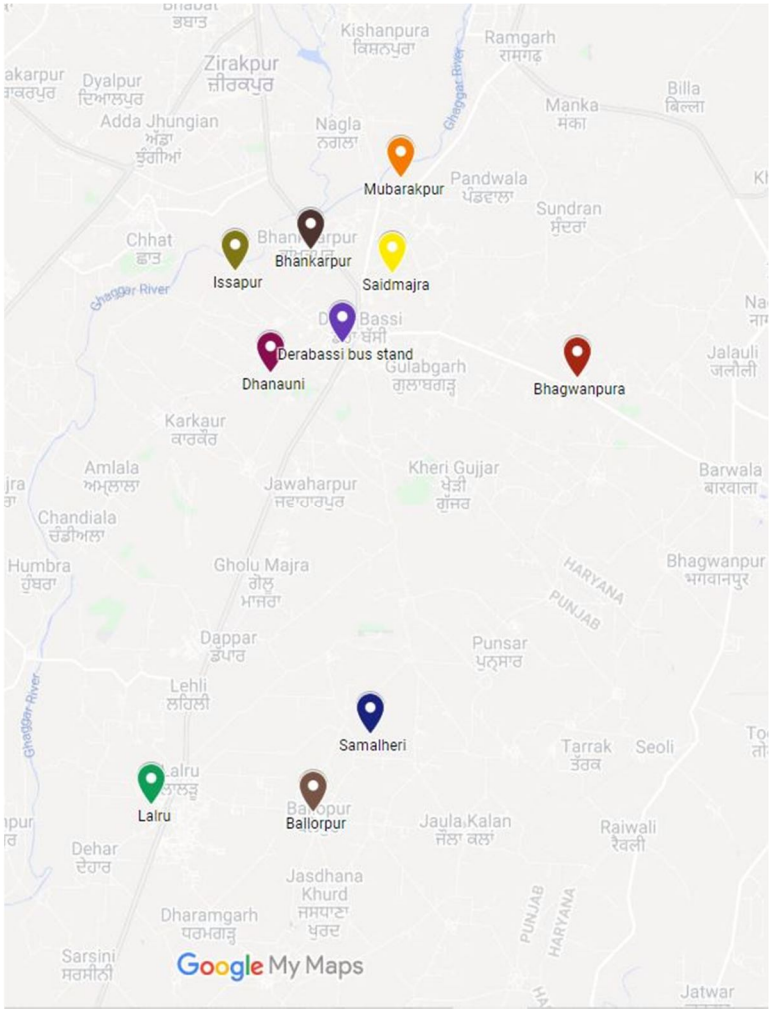


Fig. 1. Location of Groundwater Sampling Stations

2) *Various Physico-Chemical Parameters and Heavy metals Used for the Analysis ARE:* For Groundwater Quality Analysis - pH, Total Dissolved Solids, Total Hardness, Calcium, Magnesium, Nitrates, Sulphates, Chlorides, Fluorides, Cadmium, Chromium, Copper, Iron, Manganese, and Lead. All the parameters were analyzed according to the protocol prescribed by the American Public Health Association (APHA, 2005).

III. METHODOLOGY

Water samples were taken with pre-cleaned plastic polyethylene bottles. Water samples from hand pumps and tube wells were collected. Sampling, preservation, and transportation of water samples were as per standard method Groundwater samples were analyzed for parameters such as pH, Total Hardness, Total Dissolved Salts (TDS), Sulphates, Chlorine, Nitrates, Fluoride, Calcium, Magnesium, Iron, Zinc, Lead, Copper, Manganese. Cadmium, Chromium.

The groundwater samples collection and analysis were followed by standard methods. Total Hardness was determined by complex-cation using EDTA (Ethylenediamineteracetate) "Eriochrome Black T" as an indicator.

Chloride (Cl-) ion was determined with the standard silver nitrate (.01N) titration method and in the presence of 1 mL of potassium chromate (5%) as an indicator. Sulfates, Nitrates, Fluorides was estimated by using the UV–Visible spectrophotometer. Calcium, Magnesium, Iron, Zinc, Lead, Copper, Manganese. Cadmium, Chromium. were estimated using ICAP-6000 Series ICP-OES Spectrometer.

A. Methods and Equipment used in the analysis of various Physico-Chemical Parameters and Heavy metals of the Sutlej River water and Groundwater samples.

Sr. No.	Parameter	Method	Instrument/Equipment Used
1	pH	Electrometric	Digital pH meter
2	Total Dissolved Solids	Gravimetric	Drying Oven
3	Total Hardness	EDTA Titrimetry Method	EDTA Titrimetry Method
4	Nitrates	Ultraviolet–Visible Spectrophotometry	UV-2550 Spectrophotometer
5	Sulphates	Ultraviolet–Visible Spectrophotometry	UV-2550 Spectrophotometer
6	Chlorides	silver nitrate (.01N) titration	Titrimetry Method
7	Fluorides	Ultraviolet–Visible Spectrophotometry	UV-2550 Spectrophotometer
8	Calcium	Inductively Coupled Plasma Method	ICAP-6000 Series ICP-OES Spectrometer
9	Magnesium	Inductively Coupled Plasma Method	ICAP-6000 Series ICP-OES Spectrometer
10	Cadmium	Inductively Coupled Plasma Method	ICAP-6000 Series ICP-OES Spectrometer
11	Chromium	Inductively Coupled Plasma Method	ICAP-6000 Series ICP-OES Spectrometer
12	Copper	Inductively Coupled Plasma Method	ICAP-6000 Series ICP-OES Spectrometer
13	Iron	Inductively Coupled Plasma Method	ICAP-6000 Series ICP-OES Spectrometer
14	Manganese	Inductively Coupled Plasma Method	ICAP-6000 Series ICP-OES Spectrometer
15	Lead	Inductively Coupled Plasma Method	ICAP-6000 Series ICP-OES Spectrometer
a16	Zinc	Inductively Coupled Plasma Method	ICAP-6000 Series ICP-OES Spectrometer

Table – 2 Methods and Equipment used in the study

IV. RESULTS AND DISCUSSIONS

A. Groundwater Analysis

1) *pH:* The desirable limit of pH in the water for drinking purposes is 6.5 to 8.5. The pH of the water samples of the study area varies from 7.21 to 8.8. So the groundwater is alkaline in nature.
2) *Total Dissolved Solids:* The TDS values vary between 805 to 6405 mg/l is. Samalheri has the highest TDS value of 2250 mg/l. Ballopur and Lalru also exceed the maximum permissible value of 1000 mg/l and have a TDS 2080 mg/l and 1020 mg/l respectively. The other remaining sites exceed the acceptable limit of 500mg/l. Water is not suitable for drinking purposes; as the value of TDS in them is greater than 1000 mg/l.
3) *Total Hardness:* The major cations imparting hardness are calcium and magnesium. Hardness is the property of water, which prevents the lather formation with soap and increases the boiling point of water. The Total hardness value varies from 122-627.Bhagwanpur(627mg/l) exceeds the maximum permissible limit of 600mg/l.Issapur (255mg/l), Dhanauni(283(mg/l), DerabassiBusstand(277mg/l),Mubarakpur(219mg/l),Samalheri(343mg/l) Bhankarpur(324mg/l), and are within the permissible limit but exceeds the desirable limit of 200 mg/l
4) *Calcium:* The values of Ca varies from 44 to 429. While low levels of calcium in the human body may have a harmful effect, excess of Ca is also harmful resulting in the formation of concentration such as kidney and bladder stones. Issapur (429mg/l) exceeds the maximum permissible limit of 200 mg/l. Mubarakpur exceeds the acceptable limit of 75mg/l.

5) *Nitrates:* Domestic sewage, industrial effluents, natural run-off, and agricultural wastes are important sources of it. Nitrate is one of the critical nutrients for the growth of algae and helps to accelerate the eutrophication. Nitrate concentration above permissible limits of 45mg/l are found in Issapur (217mg/l), Saidmajra (68 mg/l), Dhanauni (52mg/l). The presence of nitrates affect infants and is a cause of methemoglobinemia.
6) *Sulfates:* The higher values of sulfate content may be contributed due to biochemical, anthropogenic sources, and industrial processes, etc. Sulfate is a naturally occurring anion found almost in all kinds of water bodies. This is also an important anion imparting hardness to the waters. The sulfate ion produces a cathartic effect upon human beings when it is present in excess. Issapur has the highest sulfate concentration of 140 mg/l. The permissible limit of Sulphates in drinking water is 400 mg/l. The sulfates are within the permissible limit in all the samples.
7) *Chlorides:* The chloride concentration in the study area ranges from 53 to 1100 mg/l. Bhagwanpura (708mg/l), Ballorpur(272mg/l), Mubarakpur(854mg/l), 654(mg/l), and Samalheri exceeds the desirable limit of 250 mg/l whereas Issapur exceeds the maximum permissible limit of 1000 mg/l.
8) *Fluorides:* The natural concentration of fluoride in drinking water is normally 0.1 to 1.0 mg/l. WHO has set the limit of 1.5 mg/l. There is a direct relationship between dental care and fluorosis. All the samples had fluorine content well below the limits.
9) *Cadmium:* Cadmium can lead to a lot of adverse health effects including cancer. cadmium can also cause flu-like symptoms (chills, fever, and muscle pain) and can damage the lungs. The max permissible limit for chromium is 0.003 mg/l without any relaxation. All sites exceed this value. Issapur and Lalru have the highest value.
10) *Chromium:* The permissible limit of Cr in water is 0.05mg/l. Saidmajra, Mubarakpur. Bhankarpur, Lalru, Bhagwanpura exceeds the permissible limit. Chromium is toxic to humans and the main adverse effects are on the skin, mucus membrane, and lung.
11) *Copper:* Copper is is found in some natural waters, particularly in areas where its ore deposits are mined. Copper in very small amounts is not considered detrimental to health. It may only impart disagreeable taste. The tolerance limit for in copper drinking water is 1.5mg/l. All the sites have a copper concentration within the maximum permissible limit..
12) *Iron:* Groundwater with Iron concentration above permissible limit of 0.3 mg/l were observed in 5 locations. Issapur has the highest iron concentration i.e 30.2 mg/l followed by Ballopur(8.52mg/l).), Busstand(7.23mg/l),Bhankarpur(5.81mgl) Saidmajra(.32mg/l).
13) *Manganese:* The maximum permissible limit for manganese is 0.3 mg/l .this value is exceeded by the samples with highest value at Issapur (1.11mg/l), Derabassi Busstand(.56mg/l), Ballorpur(.49mg/l).
14) *Lead:* Lead is cumulative poison and accumulates in the skeletal structures of man and animals. It has harmful effect on the central nervous system, kidney and may cause cancer and brain damage. The IS:10500 (2012) has prescribed maximum permissible limit 0.01 mg/l for drinking water. concentration of Pb greater than this has been observed in 7 out of 10 samples. Issapur(.062mg/l),Saidmajra(.037mg/l),dhanauni(.027mg/l),Busstand(,014mg/l,Mubarakpur(.068mg/l),Bhagwanpur(.026mg/l), Samalheri(.045mg/l) cross the maximum permissible limit.
15) *Zinc:* Zinc is found naturally in water, most frequently in areas where it is mined. It enters the environment from industrial waste, metal plating, and plumbing and is a major component of sludge. It also aids in the healing of wounds and causes no ill effects except in very high doses imparts an undesirable taste to water. It is toxic to plants at high levels. The maximum permissible limit for zinc is 15mg/l. None of the groundwater sites crossed this limit.

V. CONCLUSIONS AND RECOMMENDATIONS

In this study, an attempt has been made to identify the extent of contamination of major Physico-chemical parameters, nutrients, and trace metals in the study area. In this connection, groundwater samples from 10 villages of the Derabassi block of Mohali district, Punjab have been collected. During the course of study, one sample was collected as background sample from the upstream of the industrial area and away from the sources of pollution in all the study areas to establish the basic quality of groundwater Samples were collected and analyzed for various parameters from the industrial zone samples collected away from the industrial zones as background samples as per the standard methods for the examination of water and wastewater (APHA, 2002) and the results have been interpreted as per BIS. The extent of pollution in groundwater has also been analyzed by regression modeling This investigation is, therefore, a consorted effort towards the understanding of various natural and anthropogenic processes influencing the groundwater quality.

The following are the conclusions drawn based on the findings of the research work.It can be observed that the major elemental concentrations in the industrial areas of Derabassi are predominantly influenced by anthropogenic activities than natural agencies, which has resulted in polluting of overlying environment.

A. Intense industrial activities, population explosion and poor sanitation are the major threats for groundwater pollution of this region.

B. The pH value indicates that the water is alkaline in nature. The Total hardness value varies from 122-627. Bhagwanpura exceeds the maximum permissible limit of 600 mg/l. Issapur, Dhanauni, Derabassi Busstand, Mubarakpur, Samalheri, Bhankarpur(, a are within the maximum permissible limit but exceeds the desirable limit of 200 mg/l

C. The TDS levels are high. The high value of TDS in groundwater indicates high concentration of dissolved solids which cause gastro-intestinal problems in human. The TDS values vary between 805 to 6405 mg/l is .Samalheri has the highest TDS value of 2250 mg/l. Ballopur and Lalru also exceeds the maximum permissible value of 1000 mg/l and has a TDS 2080 mg/l and 1020 mg/l respectively. Water is not suitable for drinking purpose; as the value of TDS in them is greater than 1000 mg/l

D. The values of heavy metals are high in most of the samples tested. The presence of heavy metals indicates the presence of industrial effluents or nearby landfills.

E. There is no definite trend in the values of calcium hardness samples. Calcium is one of the most abundant elements found in natural water. It is an important ion in imparting the hardness to the waters. The calcium hardness of groundwater samples ranged from 138 to 366 mg/L

F. There is no definite trend in values of calcium hardness samples. Calcium is one of the most abundant elements found in natural water. It is important ion in imparting the hardness to the waters. The calcium hardness of groundwater samples ranged from 138 to 366 mg/l.

G. The natural concentration of fluoride in drinking water is normally 0.1 to 1.0 mg/l. WHO has set the limit of 1.5 mg/l. There is a direct relationship between dental care and fluorosis. All the samples had fluorine content well below the limits.

H. Nitrate concentration above permissible limits of 45mg/l is found in Issapur with concentration being 217 mg/l Saidmajra (68mg/l) and Dhanuni(52mg/l). The presence of nitrates affects infants and is a cause of methemoglobinemia.

I. The Sulphate ranges were noted between 27 to 140. The highest value being Issapur but the concentration does not exceed the maximum permissible value.

J. Groundwater with an Iron concentration above the permissible limit of 0.3 mg/l was observed in 5 locations. Issapur has the highest iron concentration i.e 30.2 mg/l followed by Ballorpur. Bhankarpur, Bustand, and Saidmajra also exceed the permissible limit.

K. Lead is a cumulative poison and accumulates in the skeletal structures of man and animals. It has a harmful effect on the central nervous system, kidney and may cause cancer and brain damage. The IS:10500 (2012) has prescribed a maximum permissible limit of 0.01 mg/l for drinking water Issapur has the highest value of Lead at 0.062 mg/l.

L. Zinc is toxic to plants at high levels.IS 10500 has limited Zn concentration at 5mg/l as an acceptable limit and a5 mg/l as the cause of rejection. None of the samples exceeds these limits.

The overall quality of water is not good and this needs urgent attention because people are suffering from health issues and in some villages, the agricultural sector which is their source of income is also being affected.

VI. RECOMMENDATIONS

A. The wastewater generated from industries should be properly treated and disposed of and strict legislation on industries setting up and operating their effluent treatment plants should be enforced mandatorily and suitable measures should be taken against the industries violating the ETP norms. Any negligence on the part of the authorities may lead to further deterioration in the quality of groundwater.

B. It is recommended that water quality analysis be carried out on all hand-dug and hand-pump wells and be disinfected at least once in a year by the appropriate authorized bodies such as the CWSA.

C. Disposals of solid wastes on a landfill are a high nuisance and become a source for groundwater contamination n and water-borne diseases. Proper management of these activities by the concerned authorities must be made for the safe disposal of solid wastes.

D. Increased and continued combined environmental interventions through public health education by community-based workers, awareness and sensitization campaigns with regard to the impact of various water-borne diseases should be carried out for improved household and community sanitation.

E. Proper drainage and sewer systems should be constructed in the magazine to ensure proper disposal of hazardous liquid waste, thereby preventing seepage into groundwater and surface water.

F. There should be a comprehensive waste management plan for the inhabitants to follow on daily waste disposal and education on the dangers of drinking polluted water.

The provision of regulatory guidance and recommended pollution prevention opportunities to help mechanics to handle their waste in cost-effective and environmentally sound ways is ideal. this may include;

1) Mechanics been made aware it is their responsibility to be able to realize hazardous waste streams from their operations and the practice of good-housekeeping that will reduce spills and waste and to conserve natural resources.

2) Adopt the strategy of reuse and recycling of materials such as used oil and brake fluids.

a) Substitute less hazardous materials to do their job.

b) Sanitation system must be improved. The benefits of cleanliness on human health need to be understood.

c) People should be aware of the effect of water pollution. Voluntary organizations can render door-to-door services to educate the people about Environ. problems.

d) Residents in the study area are at high health risk. The investigations along with the discussions held with the health centre officials and general public of the area, clearly point out to the serious contamination of the groundwater in the vicinity of the industries and the ill-health faced by the residents

e) To avoid further pollution of groundwater water and to reduce toxic elements industrial effluents need treatment before disposal. Solid waste disposal in open areas, depressions, and low lying areas need to be banned. Action is required against industrialists which do not treat industrial effluents. The presence of metals above the permissible limits in the domestic water is of serious concern; it could cause not only a change in taste but also serious ailments. The quality of groundwater is thus important to safeguard as all activities in the town depend on the long term sustainability of groundwater resources.

REFERENCES

[1] Rao MS, Purushothaman P, Krishan G, Rawat YS and Kumar CP (2014). Hydrochemical and isotopic investigation of groundwater regime in Jalandhar and Kapurthala districts, Punjab, India. International Journal of Earth Sciences and Engineering., Volume 07, No. 01.

[2] Rashid I, Romshoo SA (2013) Impact of anthropogenic activities on water quality of Lidder River in Kashmir Himalayas. Environ Monit Assess 185:4705–4719.

[3] Rout C and Setia B (2018) Assessment of groundwater quality for suitability of industrial purposes. International Research Journal of Environmental Sciences., 7(3), 8-16, March (2018).

[4] Shankhwar AK, Srivastava RK (2015) Biomass production through grey water fertigation in Eucalyptus hybrid and its economic significance. Environ Prog Sustain Energy 34(1):222–226

[5] Hakim, M.A., Juraimi, A.S., Begum, M., Hasanuzzaman, M., Uddin, M.K. and Islam, M.M., 2009, Suitability evaluation of groundwater for irrigation, drinking and industrial purposes, American Journal of Environmental Sciences, 5(3), 413-419.

[6] Indian Standards of Drinking Water, Specification (First Revision) IS-10500:1991 BIS, New Delhi, India.

[7] Jain, C. K., Bandyopadhyay, A. and Bhadra, A., 2010, Assessment of ground water quality for drinking purpose, District Nainital, Uttarakhand, India, Environ Monit ssess., 166, 663-676.

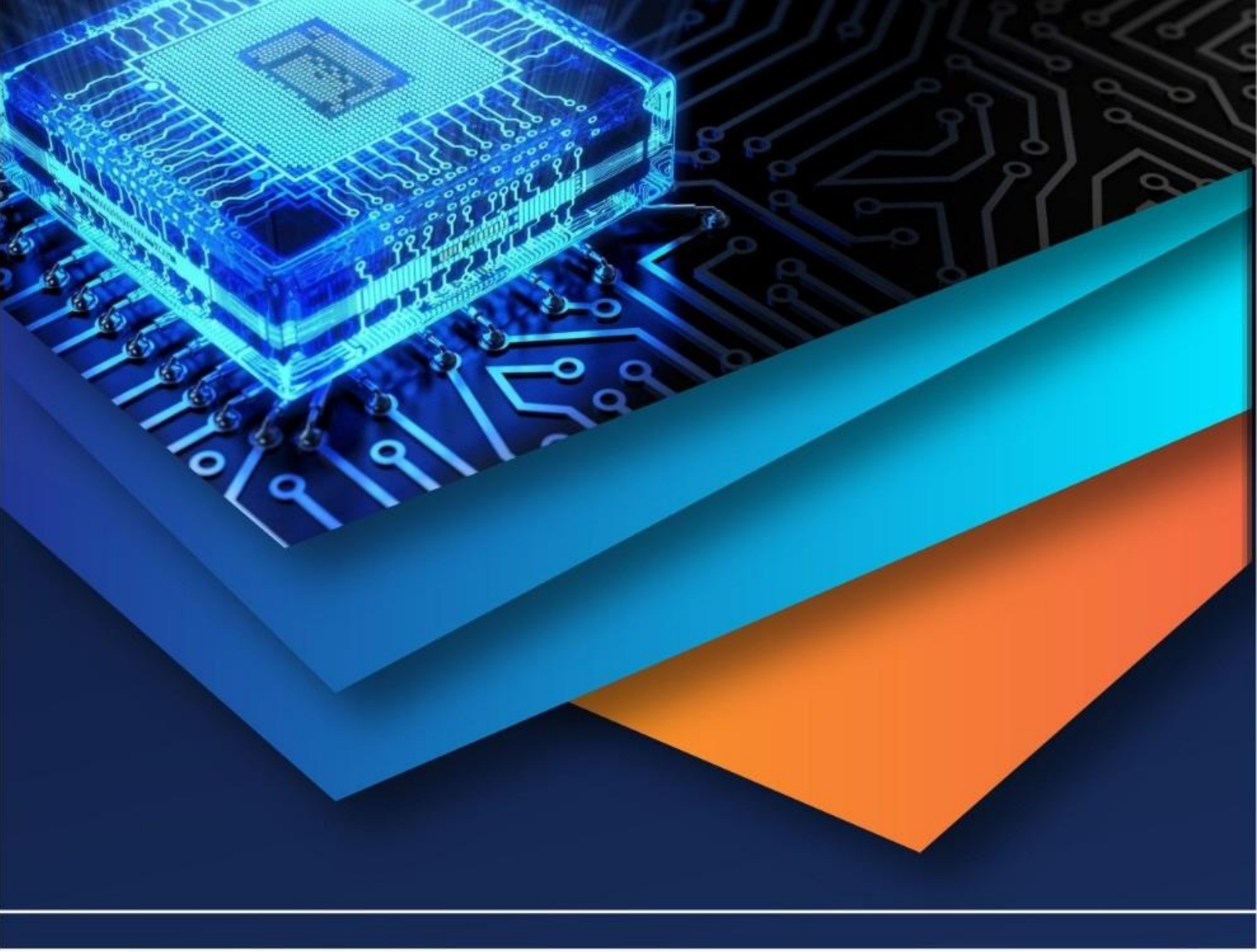
[8] Jha, A.N. and Verma, P.K., 2000. Physico–chemical property of drinking water in town area of Godda district under Santal Pargana, Bihar, Poll Res., 19(2), 245–247.

[9] Mittal, S.K., Rao, A. L., Singh, and Kumar, R., 1994, Groundwater Quality of some areas in Patiala city, Indian J Environ Hlth, 36; 51-53.

[10] Rajankar, P.N., Tambekar, D.H., Wate, S.R. 2011. Seasonal Variation in Groundwater Quality of Yavatmal District, India, E-Journal of Chemistry, 8(2), 870-874.

[11] Sreedevi, P.D., 2004. Groundwater quality of Pageru river basin, Cuddapah district, Andhra Pradesh, J Geol Soc India, 64(5); 619–636.

[12] Subba Rao, N., 2002. Geochemistry of groundwater in parts of Guntur district, Andhra Pradesh, India, Environ Geol, 41; 552–562.



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY