Water Quality and Surface Water Pollution of Gwalior City, Madhya Pradesh

Gurumayum Surbala Devi

School of Studied in Earth Science, Jiwaji University, Gwalior, Madhya Pradesh, India
gurumayumbaby93[at]gmail.com

Abstract: ***The present study was undertaken to determine the quality of water based on the physio-chemical parameters of different locations of Gwalior City. The hardness of groundwater of the city has also been determined. Water quality ranges were assessed from the composite value/ index as well as main sources of the surface water pollution is studied and the possible remedial measures have been suggested for better water quality management.***

Keywords: Groundwater, water quality, composite value, surface water, Gwalior city, water pollution

1. Introduction

Water is fundamental to life on our planet, but this precious resource is increasingly in demand and under threat. Human have constantly increased contaminating water sources due to its increasing needs (Nama and Raj, 2018). Increased anthropogenic activities in and around these water bodies affect the overall physico-chemical properties of water (Upadhyay et al., 2010). Water pollution is a serious problem in India as almost 70% of its surface water resources and growing number of groundwater reserve are already contaminated. Once the groundwater is contaminated, its quality cannot be restored easily. Inadequate management of water resources has directly or indirectly resulted in the degradation of hydrological environment (Karanth, 1998) . Therefore, a continuous periodical monitoring of water quality is necessary so that appropriate steps may be taken for water resources management practices. The quality of water plays an important role in judging its use for different purposes.

Gwalior, the fourth largest city, is situated in the northern part of the state Madhya Pradesh, and topographically falls into the north east plain, surrounded by small hills and hillocks of Vindhyan Super group such as Fort hill in the center, Guda, Gudi hill and Amkho hill in the south. It consists of 3 distinct urban areas, Gwalior in the north, while Lashkar about 3 kms to the south west and Morar towards east (which covers the Cantonment area) of Gwalior township. These areas fall within the limits of semi-arid climate marked by extreme temperature and variability of rainfall. The investigated area is one of the metropolitan city of Madhya Pradesh, India lying between the latitudes $26^0 10'$-$26^0 15'$ N and longitudes 78 $^0 07'$-$78^0 15'$ E and covering an area of about 2457 sq km, It is covered in the survey of India topographic sheet no. 54 J/4. The location and approach map of the study area is shown in **Figure-1**.

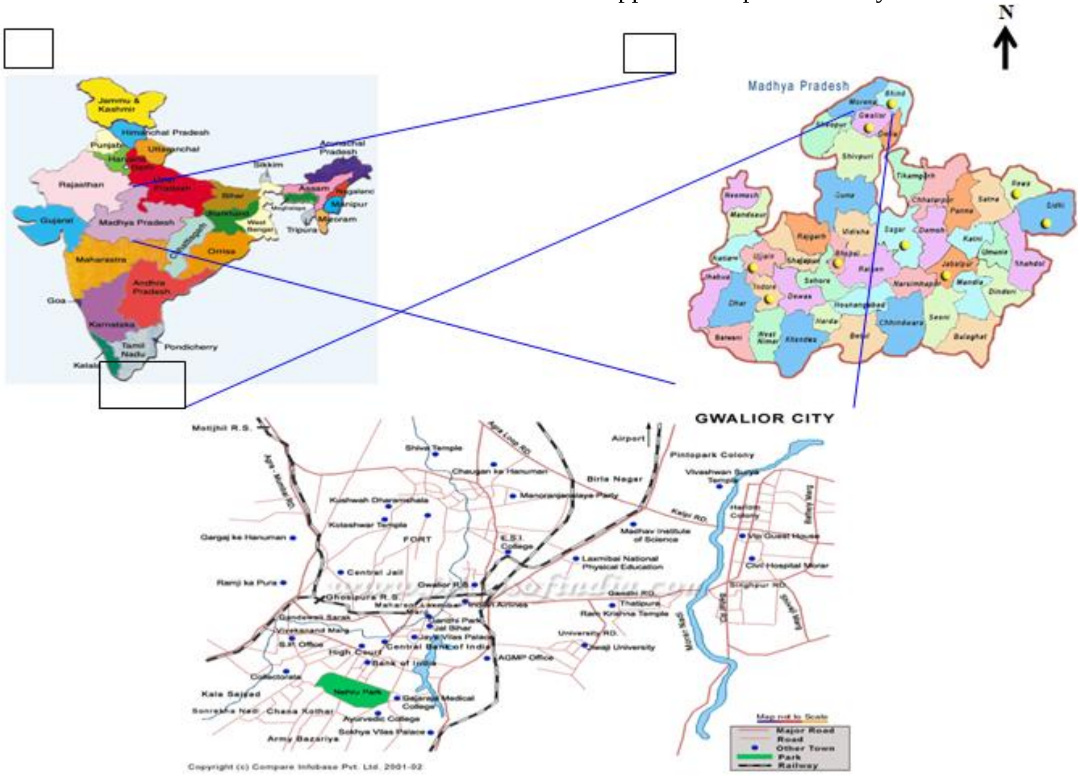

Figure 1: Location and Approach Map of the Study Area

2. Material and Methods

The quality of water plays an important role in judging its use for different purpose. Under the present investigation, the physico-chemical properties of ground water were analyzed and surface water pollution has been studied.

Water sample were collected from different areas of Gwalior city (**Figure-2)** and analyzed chemically as per the method for the estimation of calcium, magnesium, total hardness, chloride, nitrate, sodium, potassium, Alkalinity, total dissolved Solids and Electrical conductance to establish the groundwater quality.

The analytical results were compared with the standard value given by WHO (1984) and ISI (1983). On the basis of hardness, the groundwater of the area has been classified as per the standard classification of Hem (1970).

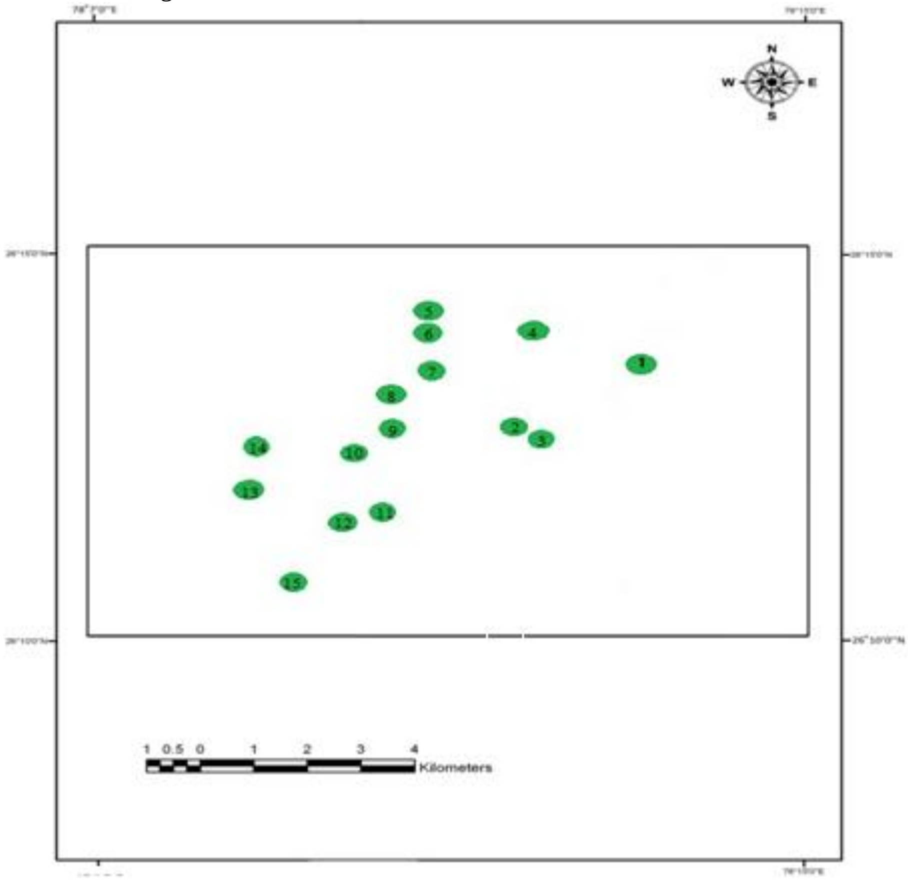

Figure 1: Location and Approach Map of the Study Area

The method of measurement of disparities (Aslam, 2002) has been applied to the above mentioned groundwater analysis of the study area to portray some of the complex characteristics which are not directly observable. As these characteristics are only partially reflected by several variables, all those have to be measured through the related variables. A composite picture from properly chosen variables may be extracted by working out a composite index from them. Standardized values are calculated to find out the composite index by using the formula:

Standardized value (SD value) = $\frac{x-\bar{x}}{Sd}$

Where, x= Variable
$\bar{x}$ = Mean Variable
Sd = Standard deviation

S D value = the mean of variable is subtracted from its different values and this difference is then divided by its sd (standard deviation).

Composite index = $\frac{Grossvalue}{N}$

Where, Gross value = Sum of all variable
N = Number of variable taken

Composite index = Gross value (sum of variables) divided by N (no. of variables taken).

3. Result and Discussion

The measured values of different physico-chemical parameters of collected samples are summarized in Table-1. From the data, the calcium and magnesium contents in the water sample collected from the city is found in the range of 40 to 360 and 1.3 to 95.25 mg/L respectively. Higher values of calcium may be attributed to the existence of calcium rich soils.

Table: 1 Physico-Chemical analysis data of groundwater constituents of the Study Area

Location	Ca	Mg	Na	K	Cl	NO_3	TH	Alk	TDS	EC
Morar	62	60.86	113	2.4	142	100	405	69	679	1292
Thatipur	40	49.9	44	4.3	32	2.5	62	72	751	729
Govindpuri	42.5	38	57	4.5	30	1	60	74	840	685
GoleKaMandir	56	49.89	69	3.6	30	5	68	80	798	72
Ghospura	64	52.1	73	216	240	2	130	180	760	1291
HaziraChowk	71	64.5	75	3.6	39	2.1	401	115	580	967
Tansen Nagar	63	61.86	261	22.1	120	2.3	132	180	1980	1194
Kherapati Temple	264	25.76	76	15.1	130	4.08	208	353	920	2115
PhoolBagh	360	36.45	9	17.6	130	3.96	510	240	660	1320
Shindekichawni	68	1.3	80	164	97	7.09	72	158	1060	462
PardiMohalla	50	35	50	6.4	150	3.54	206	350	781	2112
Kampu	66	61.4	71	16.2	150	1.9	200	300	587	850
Hanuman Chauraha	44	13.6	70	6.8	200	12.2	100	270	400	1320
Laxmiganj	59	30.2	48	6.3	130	2.4	380	340	512	590
GudaGudika Naka	168	95.25	51	66.5	40	3.55	560	480	780	924

Magnesium is also present along with Calcium in natural water although in lower concentration than calcium and has similar sources of entry. Hardness of water mainly depends upon the amount of calcium or magnesium salts or both. It is not deleterious to health although it has been suspected to be playing some role in heart diseases (Prabhavathi, 2005). The total hardness values range from 61 mg/L to 560 mg/L.

As per the standard classification of Hem (1970), the degree of groundwater hardness of the Gwalior city varies from soft to very hard (Table- 2).

Table 2: Classification of Groundwater of the Study Area based on Hardness as CaCO3 (after Hem, 1970)

Hardness as CaCO3(mg/L)	Degree of Hardness	Locations
0-60	Soft	Govindpuri
61-120	Moderately Hard	Thatipur, Gole Mandir, Shinde Ki Chhawni, Hanuman Chauraha
121-180	Hard	Ghospura and Tansen Nagar
>180	Very Hard	Morar, Hazira Chowk, Kherapati Temple, Phool Bagh, Pardi Mohalla, Kampu, Laxmiganj, Guda Gudi Ka Naka

Content of Sodium (Na) varied from 9 to 261 mg/liter. As per WHO standards, they are well within the permissible limit except in Tansen Nagar where the Sodium content has been found to be high possibility due to the existence of the nearby industrial activities. Potassium contents vary from 2.4 to 22.1 mg/L except in Guda Gudi ka Naka (66.5 mg/L). The study reveals that the potassium content in general, is within the permissible limits as prescribed by WHO standards. The chloride concentration was found in the range of 30 to 240 mg/L. The values are within the permissible limits. The Nitrate contents in the groundwater vary in the range from 1 mg/l to 12.2 mg/L except in Morar, which is found to be 100 mg/L. The presence of little higher Nitrate value in water is an indication of pollution due to discharge of sewage water, industrial effluents, over-application of fertilizers, improper manure management practices etc., without proper treatment directly into the river.

Alkalinity value in water provides an idea of natural salts present in water. The causes of alkalinity are the minerals which dissolve in water from soil. Alkalinity of water is due to the presence of carbonate, bicarbonate and hydroxide compounds of calcium, sodium, and potassium. The total alkalinity of the groundwater samples ranged between 69 to 480 mg/L. The Alkalinity values observed in groundwater samples of Morar, Thatipur, Govindpuri, Gole Ka Mandir, Ghospura, Hazira Chowk, Tansen nagar and Shinde ki Chhawni are within the desirable limits of ISI: 10500. However, the higher values were observed at Kherapati Temple, Phool Bhag, Pardi Mohalla, Kampu, Hanuman Chauraha and Laxmiganj while reaching at the highest level of 480 mg/L at Guda Gudi Ka Naka.

The concentration of dissolved solids in water gives an idea about its suitability for various uses including that of potable water. The values of the TDS of the area under investigation vary from 400 to 1060mg/L falling within the maximum permissible limits, but at Tansen Nagar the values exceeds up to 1980 mh/L. The water with higher contents of TDS having inferior portability can induce an unfavorable physical reaction in consumers.

Electrical conductivity is an important parameter for determining the water quality for domestic and agricultural purpose. EC values of groundwater of the study area are in the range of 462 to 2115 micromhos. High EC values were observed in groundwater samples of Kherapati temple and Pardi Mohalla which indicates the presence of high amount of dissolved inorganic substance in ionized form. The result reveals that the groundwater of the above mentioned location is unfit for human consumption.

Furthermore, the Composite value range (Table-3) obtained for the different areas have been compared with the water quality ranges of Mathur and Kalia (2007) and the water quality categories were assessed (Table-4). Lower the composite value, better the water quality.

Table 3: Standardized values of Groundwater Quality for different zones of the Study Area

Zones	Ca	Mg	Na	K	Cl	NO3	TH	Alk	TDS	Gross value	Composite value
Morar	-0.004	0.68	0.14	-0.53	0.58	3.59	0.99	-1.15	-0.34	3.95	0.43
Thatipur	-0.62	0.2	-0.51	-0.54	-1.1	-0.3	-0.99	-1.13	-0.15	-5.14	-0.57
Govind puri	-0.61	-0.3	-0.62	-0.5	-1.13	-0.36	-1	-1.12	0.09	-5.53	-0.61
Gole ka Mandir	-0.45	0.2	-0.51	-0.14	-1.13	-0.2	-0.59	-1.07	-0.02	3.91	-0.43
Ghospura	-0.36	0.3	16.89	26.09	2.08	-0.32	-0.59	-0.29	-0.12	43.68	4.85
Hazira Chowk	-0.29	0.83	0.05	-0.01	-0.99	-0.32	0.97	-0.79	1.35	0.8	0.08
Tansen Nagar	-0.32	0.72	3.51	-0.23	0.24	-0.31	-0.58	-0.29	3.22	5.95	0.66
Kherapati Temple	1.77	-0.83	0.07	-3.13	0.39	-0.24	-0.14	1.05	0.31	-0.75	-0.08
Phool Bagh	2.78	-0.37	-1.16	-0.29	0.39	-0.25	1.6	0.17	-0.4	2.47	0.27
Shinde Ki Chhawni	-0.32	-1.88	0.15	2.4	-0.1	-0.12	-0.93	-0.46	2.67	1.41	0.15
Pardi Mohalla	-0.51	-0.43	0.89	-4.5	0.7	-0.26	-0.15	1.03	-0.06	-3.29	-0.36
Kampu	-0.34	0.7	-0.01	-0.32	0.7	-0.33	-0.18	0.64	-0.6	0.26	0.02
Hanuman Chauraha	-0.58	-1.35	-0.03	-0.46	1.47	0.07	-0.77	0.41	-1.11	-3.35	-0.37
Laxmiganj	-0.42	-0.64	-0.44	-0.47	0.39	-0.31	-11.3	0.95	-0.8	-13.04	-1.44
Guda Gudi Ka Naka	0.74	-1.54	-0.38	0.45	-0.98	-0.26	1.89	2.05	-0.07	1.9	0.21

Hence, the water Quality of the Gole Ka Mandir, Kherapati temple, Pardi Mohalla, Hanuman Choraha, Laxmiganj comes under the category of best as the composite value is below -0.5.

Table 4: Water Quality of the Study Area

S. No	Composite Value	Zones	Category
1	Below -0.5	Gole Ka Mandir, Kherapati Temple, Pardi Mohalla, Hanuman Chauraha, Laxmiganj	Best
2	-0.5 to 0	Thatipur, Govindpuri,	Better
3	0 to 0.5	Morar, Hazira Chowk, Phool Bagh, Shinde Ki Chhawni, Gudi Guda Ka Naka, Kampu,	Good
4	Above 0.5	Ghospura,Tansen Nagar	Ok

Surface water pollution is a major problem resulting from rapid population growth, urbanization and industrialization. The two major rivers of the investigated area–the Swanrekha and the Morar (Kalpi) are contaminated by domestic sewage released by local inhabitants. Apart from this other human activities are also causing pollution to these rivers, deteriorating their quality and converting them largely as black coloured, highly stinking sewage channels. Rapid growth of Gwalior city has affected the existing drainage and sewerage system. The worst example is that of the Swarnrekha River, which is flowing through the middle of the city. The river is completely choked by the disposal of solid waste, garbage and leakages from broken sewerage lines. That also causes organic pollution due to anthropogenic activities. Small scale industries along the river add to toxic chemical pollution in it, also the construction of a number of unauthorized buildings on either bank converting the river more or less a Nala. Solid waste dumping in the open area in the catchment affects the water quality.

The Morar (Kalpi) river originated from Ramaua dam. The river while flowing through the city receives the discharge of waste water through number of drains, leakages from the sewage lines and disposal of solid waste highly affecting the river water making its quality worst.

In the light of the above findings, the following measures are suggested for better surface and sub-surface water quality management.

- All domestic and municipal effluents should not be discharged directly into local drains, nalas, and river or into the groundwater.
- The sewage must delink with the water bodies.
- The drinking water sources and their nearby area be kept clean and regular periodic cleaning be maintained.
- Use of pesticides in agriculture should be limited and only standard quality pesticides be used.
- Legal framework, public awareness and law enforcement to mitigate sources of the pollution are key strategic lanes to be put in place.
- Municipalities to invest in appropriate waste water treatment plants.
- Farmer to better control the use of fertilizers and pesticides.
- Scientific community to develop studies and surveys that allow better understanding of links between surface water and aquifer mechanism of dilution of pollutants.
- Public Authorities to regulate and create awareness.
- Public involvement is an essential factor of success as shown in many places world-wide.
- To protect groundwater resources from pollution, a scientifically designed water-quality monitoring program is to be established.
- Urban growth should be preceded by a thorough examination of hydrogeological conditions of the respective towns.
- Top priority must be given to protect these water resources from the contaminations by anthropogenic activities.

References

[1] Aslam, M. (2002): Statistically methods in geographical studies. Rajesh Publication, New Delhi, 4th Edition, 87-100.
[2] Donohue, I., Style, D., Coxon, C., and Irvine, K. (2006): Importance of spatial and temporal patterns for assessment of risk of diffuse nutrient emissions to surface waters. Jour. of Hydrology (Amsterdam), 304, 183-192.
[3] Hem, J.D. (1970): Study and interpretation of the chemical
[4] characteristics of natural water. 2nd ed. USGS Water Supply Paper 1473, 363.

[5] Indian Standards Institution (ISI) (1983): Indian standards specifications for drinking water. IS: 105000, ISI, New Delhi, 11, 1-22.
[6] Karanth, K.R. (1989): Hydrogeology. Tata MC Graw Hill Publishing Company Ltd., New Delhi.
[7] Mathur, Priti and Kalia, Sarina (2007): Water quality assessment and control-Jaipur city. Indian Jour. of Environ. Sci., 11(1), 37-39.
[8] Nama, Pankaj and Raj Dhan (2018). Water quality assessment using physio- chemical Parameters of Palasani Pond, Jodhpur District, Rajasthan, India 5 (3), 1-4 http:llijrar.com
[9] Prabhavathi (2005): A sstudy of fluoride levels in drinking water of Elampalli area of Salem District. IJEP, 25(3), 231-234.
[10] Upadhyay K, Mishra P and Gupta AK, (2010): Studies on the Physio-chemical status of two ponds at Varanasi and Bhadhohi under biotic stress, plant Archives 1(2) 691-693.
[11] World Health Organization (1984): Guidelines for drinking water quality, Geneva.

Author Profile

Gurumayum Surbala Devi received the B.Sc (Zoology) from Manipur University and M.Sc. degrees in Geology from Jiwaji University, Gwalior (India) in 2003 and 2006 respectively. In 2011, she has been awarded Doctorate Degree from Jiwaji University after 5 years of research on Topic 'Geo-Environmental Appraisal of the Gwalior Metropolitan City, Madhya Pradesh (India)'. She went to Bengaluru to teach Science at Narayana e-Techno School from 2014 to 2016. Currently, she is a keen author of environmental related research paper.

Paper ID: SR22525195947 DOI: 10.21275/SR22525195947