IMPACT OF URBANIZATION ON WATER RESOURCE OF LUCKNOW URBAN CENTRE

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Abstract— **Lucknow being capital city of most populated state of India is facing tremendous population pressure. This has led to overexploitation of natural resources and among them water is most valuable natural resource essential for human survival and ecosystem. This study monitors ground water quality, relating it to land use/land cover and habitation mask of different water quality parameters are prepared by using geographic information systems (GIS) and remote sensing technique. Base map was prepared by Survey of India toposheets on 1:50.000 scales. The land use / land cover map was made from satellite imagery and GIS software Imagine and ARC GIS 9.1. The ground water samples were collected from the selected locations and were analyzed for different physico-chemical analysis and a water quality index was prepared. Water quality index (WQI) was then calculated on the basis of WHO standards to classify suitability for drinking water. The WQI map was interpolated using inverse distance weight (IDW) method on GIS for spatial variation and suitability of quality assessment.**

Keywords: **Remote sensing, ground water, water quality index, urban sprawl, inverse distance weight (IDW) method, WHO standard.**

I. INTRODUCTION

Urbanization is characterized by clustering of people in relatively small areas and is recognized as an inevitable historical process (UN, 2004). The urbanization leads to many changes which have adverse impacts on Environment, including ecology, especially hydro-geomorphology, water resources and vegetation. Rapid growth of urban areas has further affected the ground water quality due to over exploitation of resources and improper practices (Mohrir et al., 2002). Lucknow is the capital city of the most populous state Uttar Pradesh and is one of the fastest developing urban centers of India. Lucknow district is a part of Central Ganga Plain covering an area of 2, 528 km^2. and lies between North latitudes 26°30' and 27°10' and East longitudes 80°30'and 81°13'Lucknow is the capital of India's most populous state, Uttar Pradesh and is situated about 500 km southeast of New Delhi in the heart of the state. The City has a humid subtropical climate with a cool dry winter from December to February and a hot summer from April to June. The temperature extremes vary from about 45 degrees Celsius in the summer to 3 degrees Celsius in the winter. The City receives about 100 cm of annual rainfall mostly from the southwest monsoons between July and September. The city lies at an average altitude of 110 meters above mean sea level and generally slopes to the east. Lateral slopes are towards the River Gomti, which flows from north-west to south-east through the heart of the city, dividing it into the ***Trans-Gomti*** **and** ***Cis-Gomti*** **regions.**

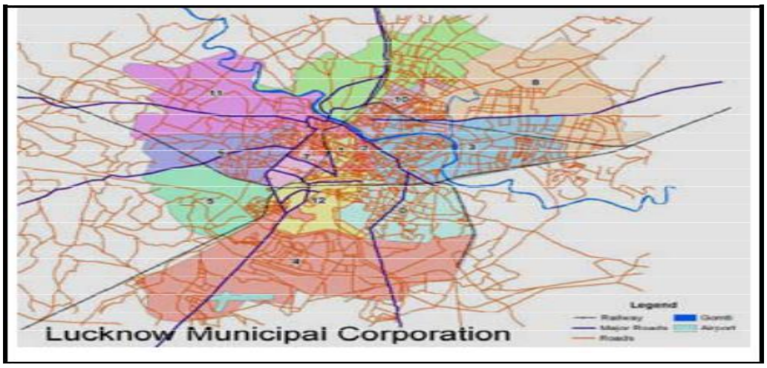


Figure 1.1

The additional densely inhabited area unit as of the town are on the southern bank of the watercourse Gomti and several other planned residential colonies are developed to the north of the watercourse.Lucknow is known for its cultural heritage

II. LITERATURE SURVEY

The following study has been conducted across global and our country is given below.-

1. Kumar**,** et al. A comparison of the areas estimated for urban, water bodies and vegetation was done to identify the land increase and decrease over a period of 37 years. The results show that the urban areas increased by421.61 km2 and the water bodies had drastically decreased by 107.844 km2, and the land under vegetation had drastically decreased by 6075.78 km2. This pattern was accounted as a total sum for the entire three districts.

2. Sivaraj,et al. With increasing urbanization, both the quantity and quality of water is affected. This study attempts to assess the influence of urbanization especially changing land-use patterns on the water quality and quantity in Ooty town of Nilgiris district, Tamilnadu, India. The study area is a rapidly urbanizing region with land development progressing at a fast pace. To study the impact of this rapid urbanization and overall land-use transition, groundwater quality parameters are checked and spatial maps are prepared within geographical information system (GIS) using ArcGIS software

Global studies –

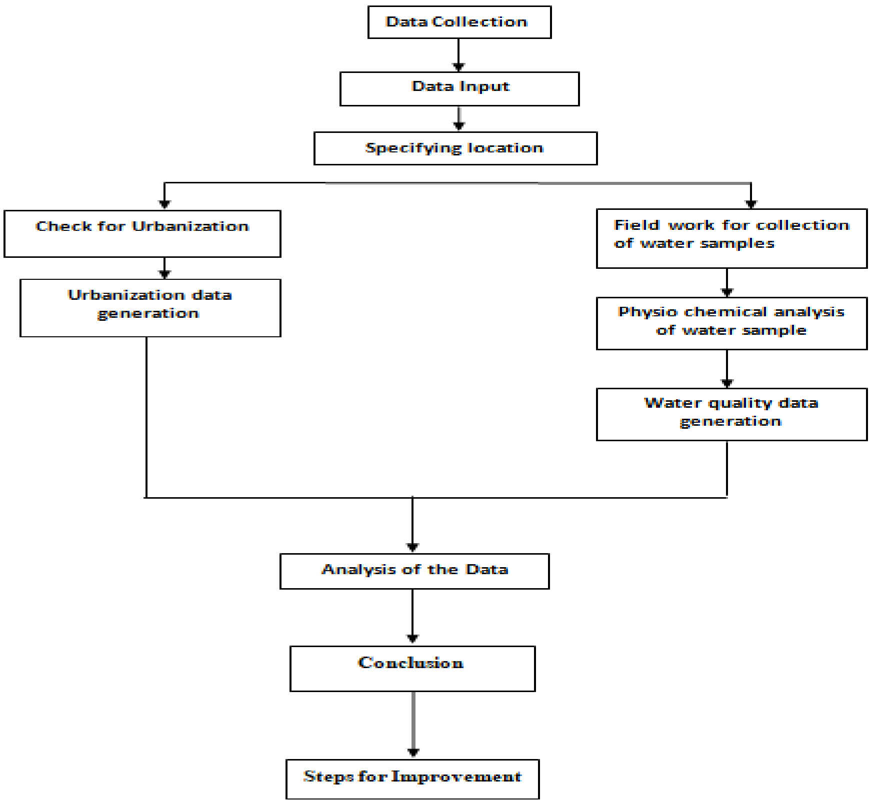
1. K. M. IBE,et al The study area is underlain by the Benin formation of Miocene – recent age. This constitutes the sedimentary formation which contains the aquifers. The geology controls the occurrence and type of aquifers; see Figure 1b. The underlying Benin formation consists of thick unconsolidated sand interfingered with clay sand lenses. The sand and clay intercalations consitute a system of aquifers separated by aquitards.

THE CURRENT STATUS

As economies of countries continue to boom they are most likely to be accompanied by expanding cities and growing urban industries and in turn would most likely, without exception, have to face major water shortage and other resultant environment problems. It is estimated that with the current practices the world will experience a 40% shortfall between the demand and available supply of water by 2030 (World Bank, 2017). These figures are further aggravated by the current chronic water scarcity, hydrological uncertainty, extreme weather conditions of floods and droughts, rapid development, pollution and inefficient utilization of water. Water scarcity and security is largely becoming a major challenge for many countries. Water resources are dwindling and this has profound implications for food security, people's health and the functioning of aquatic ecosystems.

III. METHODOLOGY

The work procedure for our project has been summarized under the following flow char-



IV. STUDY AREA

Lucknow district is a part of Central Ganga Plain in the state of Uttar Pradesh covering an area of 2,528 km^2 and lies between North latitudes 26°30' and 27°10' and East longitudes 80°30'and 81°13' (Figure 1) with total population of 34 lakhs as per 2011 (Anonymous, 2011]. General elevation of the district varies betweenand 130 (Anonymous, 2009-10) meters above mean sea level showing southeasterly slope. The climate of Lucknow city is of subtropical type with three distinct seasons namely summer, monsoon and winter. The maximum temperature remains 45°C during month of May and minimum temperature remains 5°C during January. The average annual rainfall of the city is 1014.7 mm. The following selected area are given below-

- Hazratganj

- Chowk
- Rajajipuram
- Qaisarbagh
- Cantoment
- Aliganj
- Munsipuliaindiranagar
- Gomtinagar
- Almbagh
- Charbagh

V. Tests For Ground Water Quality

The parameters which are analysed for the ground water quality determination for drinking purpose.

- Colour
- Odor
- Turbidity
- pH
- Total hardness
- Chlorides
- Nitrate
- Fluoride
- Residual chlorine
- Heavy metals (As, Pb, Fe, Cd, Cu, Cr, Ni, Zn)
- Conductivity
- Alkanity
- Ca^{++}
- Mg^{++}
- Sulphate
- Phosphate
- Colliform

In our project work we performed test for following parameters..

- pH
- Chloride
- Hardness
- Fluoride
- Turbidity

VI. Testing For Various Parameters Of Collected Ground Water Samples

Test procedure (By Field Kit)

Procedure for pH Test

Required Items:

- Beaker
- pH roll disc

Procedure:

1. Take the sample In a beaker.
2. Tear off one cm length of pH strip form pH paper with dry hand.
3. D:p the pH strip in the water sample for 5 seconds.
4. Take out the strip from the sample and compare the developed colour with the colour chart printed on the pH booklet and read the vpH value.

Required items:

- Turbidity standard ampoule (10 NTU)
- Turbidity standard ampoule (25 NTU)
- Sample bottle.
- Measuring cylinder (10 ml.)

Procedure:

1. Take 20 ml sample water in turbidity sample bottle and cap it.
2. Shake the turbidity standard ampoules 10 and 25 NTU providedin the kit and keep them near the sample water bottle.
3. Compare the appearance of the water in all three bottles.
4. Report the turbidity of sample water as

a. Less than 10 NTU
b. Between 10 and 25 NTU
c. More than 25 NTU
5. If the water sample is 10 NTU it is fit for drinking.
6. If the water sample is more than 10 NTU it is not fit for drinking.

Procedure for Chloride Test

Required items:
- Chloride reagent-“A” Reagent No.-1
- Chloride reagent-“B” Reagent No.-2
- Measuring cylinder (10 ml.)
- Beaker

Procedure:
1. Take 10 ml of sample water in a beaker with the help of a measuring cylinder.
2. Add 2 drops of chloride reagent-a(1) and mix well.

The solution becomes yellow.

3. Titrate with chloride reagent-B(2) drop wise with stirring and carefully counting the no. of drops used till the colour of the solution changes to brick red.
4. Count the no. of drops required for coloue change.

Calculation:
The chloride content in the water can be calculated by following formula.
No. of drops of chloride reagent-B(2)*25 ___________mg/1 of chloride.

Procedure for Hardness Test:
Required Items:
- Hardness reagent-“A” Reagent No.-3
- Hardness reagent-“B” Reagent No.-4
- Hardness reagent-“C” Reagent No.-5
- Measuring Cylindr (10 ml.)
- Beaker

Procedure:
1. Take 10 ml of water sample in a beaker with the help of measuring cylinder.
2. Add 5 drops of Hardness reagent-“A”
3. Add 2 drops of Hardness reagent-“B” solution and mix well. The color of the solution will become wine red.
4. Titrate drop wise with constant stirring with Hardness reagent-“C” and count the number of drops used till the color changes to distinct green-blue color.
5. Count the number of drops of Hardness reagent-“C” solution required.

Calculation:
Hardness in water in ppm or mg/1 of $CaCO_3$ can be calculated by following formula.
No. Of drops of hardness reagent-C used * 15 = ________mg/1 of $CaCO_3$

Procedure For Fluoride Test
Required Items:
- Fluoride reagent-“A” Reagent No. 11
- Measuring cylinder (10 ml.)
- Test tube with cork (25 ml.)

Procedure:
1. Take 4 ml. of the water sample and pour it into the clean 25 ml. test tube.
2. Add 15 drops of Fluoride reagent-A(11) to the 25 ml sample test tube.
3. Replace the rubber cork tightly.
4. Invert gently several times to mix the contents to develop color.
5. Place the test tube on Fluoride color chart Record the Fluoride value in mg/1. W
6. Water is safe for drinking or not, this information is given in the color chart.

VII. PROCEDURE FOR pH VALUE TEST (BY pH METER)

A pH meter measures pH and temperature, and adjusts the reading according to the temperature of the sample (as pH varies with temperature).

Equipment

The equipment you will need for this method includes:

- pH Meter
- Flow Cell
- Sample Bottle
- Deionised Water
- Calibration Solutions and Containers.

Calibration

A good quality pH meter can detect minimum variations (sensitivity) of 0.01 pH units in water and can be calibrated at two or three pH levels. This type of instrument will give more accurate readings over a wider pH range than one- point calibration meter. Meters must be calibrated with buffer solutions before each sampling trip and periodically during sampling, e.g., every tenth samplw, to check if the meter has drifted off calibration. You check on the calibration standard should be within 0.1 pH units of the buffer used. If you are using a two-point calibration meter, use buffer solutions at 4.01 and 7.00 for instance. If you are using a three-point calibration meter, use buffer solutions at 4.01, 7.00 and 10.01 for instance, Buffer tablets or powder pillows can be purchased form test kit supply companies and must be used within their expiry date. A buffer solution of pH 4.01 will last three months, but a solution of pH 7.00 will last six months if stored in a cool dark place.

Procedure

1. Rime the electrode well with deionised water/
2. Place the electrode in the sample. Wait 2-3 minutes for the reading to stabilize but be awarethat some change will occur as pH reacts with carbon dioxide dissolving from the air.
3. Record the result on the Bore Information and Field Analyses Sheet (refer Appendix
4. Within the laboratory, periodically measure the pH of the calibration solution to test accuracy. If it has drifted, recalibrate the electrode using anew buffer solution.

Maintenance

Always follow manufacturer's recommendations. If not available, rinse the electrode well with deionised water, replace cap with 3M KCI solution when finished. After field work is completed or at any singh of electode sluggishness or poor performance, clean the electrode with the manufacture's recommended cleaning solution. A storage solution may also be recommended for medium term electrode storage.

Formula used:

Water quality index (WQI)

Water quality index is regarded as one of the most effective way to communicate water quality (Sinha et al., 2004; Srivastava et al., 1994) WQI of water collected from 52 (22 + 30) locations of urban and sub-urban areas of Lucknow district were calculated. It is very useful method for assessing water quality of drinking water. In this a rating scale is fixed on the basis of importance and incidence on the overall quality of drinking water I terms of different physic-chemical parameters (Anonymous 2009-10; Horton, 1965). For calculating WQI different formulas given below are used (Sinha et al., 2006; Singh et al., 1999).

(i) Water Quality Rating, $Qn = [(Va- Vi) / (Vs- Vi)] \times 100$ (1)

Qn = Quality rating for total water quality parameter.

Va = Actual value of parameter obtained from Laboratory analysis. Vi = Ideal value of the parameter obtained from the standards. (For pH it is 7 and for others it is zero).

Vs = Value recommended by BIS India of water quality.

(ii) Unit weight $(Wn) = K / Sn$ (2)

Sn is accepted drinking water quality standards by ISO K = Proportionality Constant

Calculated by $K = [1 / (\Sigma\ ^{n} n = i\ 1/Si]$

Sn = Standard values of the water quality. Based on the above water quality values, the water samples quality is categorized as Excellent, Good, poor, Very Poor, Unfit for Drinking (Tiwari et al., 1985) (Table 2).

VIII. LAND USE LAND COVER DISTRIBUTION

Land use change with time has great impacts on the environmental quality of the area. The change in land use is highly associated with ground water quality Dasgupta et al., 2001). In the present study the land use has been classified into ten classes. In the overall

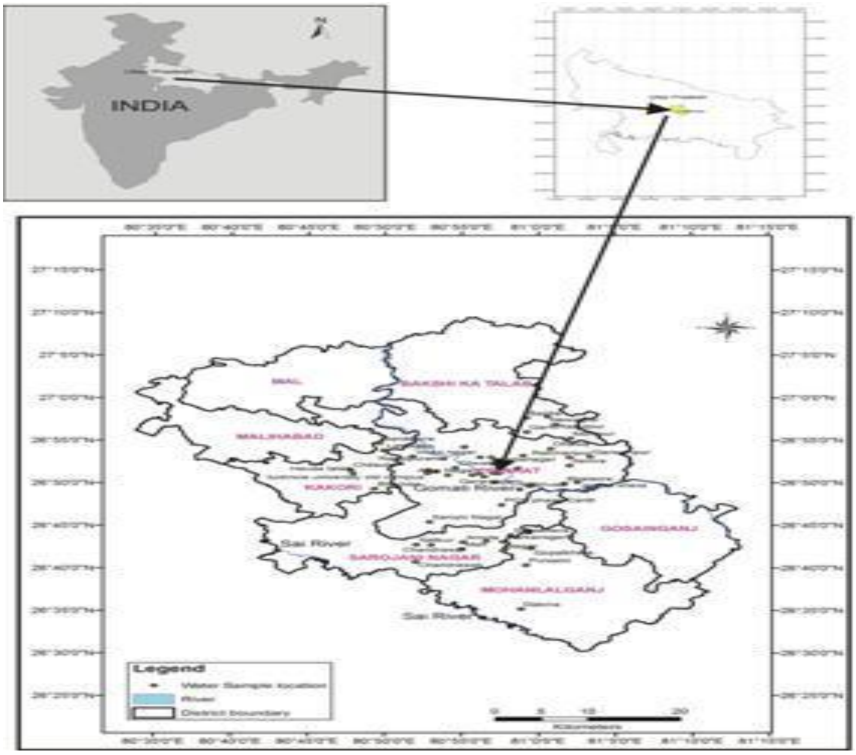


Figure 3.1 Location map of the study area -Lucknow city, Uttar Pradesh, India.

Table 3.7. Parameter wise standards and their assigned weight.

S. No. (Wn)	Parameter	BIS standard	Assigned unit Wt.
1	pH Value	8.5	0.09818
2	Hardness	300.00	0.0027818
3	Chloride	200.00	0.0041727
4	Nitrates	50.00	0.00441347
5	Sulfate	250.00	0.0033381
6	Fluoride	1.00	0.8345365
7	Calcium	100.00	0.0083454
8	Magnesium	30.00	0.02738179
9	Sodium	200.00	0.0041727

F

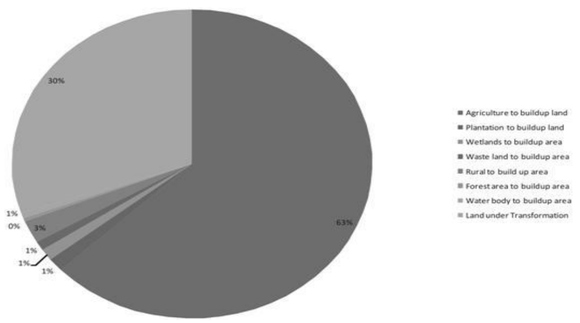


Figure 3.3 Landuse / Land cover map of lucknow district.

IX. RESULTS AND DISCUSSION

The following data collected for analysis is given below-

Table 4.1 Physico-chemical analysis of water of Lucknow district. (2018)

S. No	Locations	pH	Turbidity	Hardness	Cl	F	Category of water
1	Indira Nagar	7.2	7	420	100	1	Very poor
2	Gomti Nagar	7.6	9	140	125	1	poor
3	Hazratganj	7.8	9	330	175	1	poor
4	Chowk	7.4	8	360	75	1.5	Good
5	Rajajipuram	7	6	360	125	1	Good
6	Charbagh	7.3	5	465	125	1	Good
7	Alambagh	6.6	8	420	100	1	UBD
8	Qaisarbagh	7.3	6	375	100	1	Good
9	Contonment	7.3	6	195	150	1	UFD
10	Aliganj	7.0	5	555	225	1.5	poor

Table 4.2. Physico-chemical analysis of water of Lucknow district. (2009)

S. No	Locations	pH	Turbidity	Hardness	Cl	F	Category of water
1	Indira Nagar	7.2	6	230	5	0.61	poor
2	Gomti Nagar	7.6	8	140	11	0.32	Good
3	Hazratganj	7.8	7	210	9	0.87	UFD
4	Chowk	7.5	7	240	18	0.63	Good
5	Rajajipuram	7.5	5	370	13	0.55	Very poor
6	Charbagh	7.7	6	210	17	0.45	Very poor
7	Alambagh	6.8	7	310	21	0.36	UFD
8	Qaisarbagh	7.7	9	210	23	0.35	Poor
9	Contonment	7.2	7	310	15	0.42	Poor
10	Aliganj	7.3	9	185	22	0.38	Poor

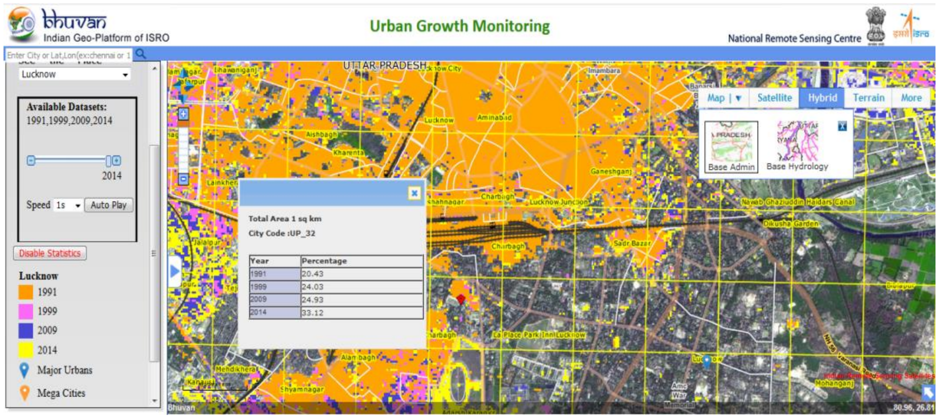


Fig 4.1 Location: HAZRATGANJ

	Physiochemical parameter	Recommending agency	Permissible value (Vs) (mg/l)	Ideal value(Vi)
	pH	**B.I.S.**	**8.0**	**7.0**
	Chloride	**B.I.S.**	**250**	**0.0**
	Hardness	**I.C.M.R.**	**300**	**0.0**
	Fluoride	**B.I.S.**	**1.5**	**0.0**
	Nitrate	**B.I.S.**	**45**	**0.0**

The following correlatios between water quality index and urbanization data determined,represented in graph is given below-

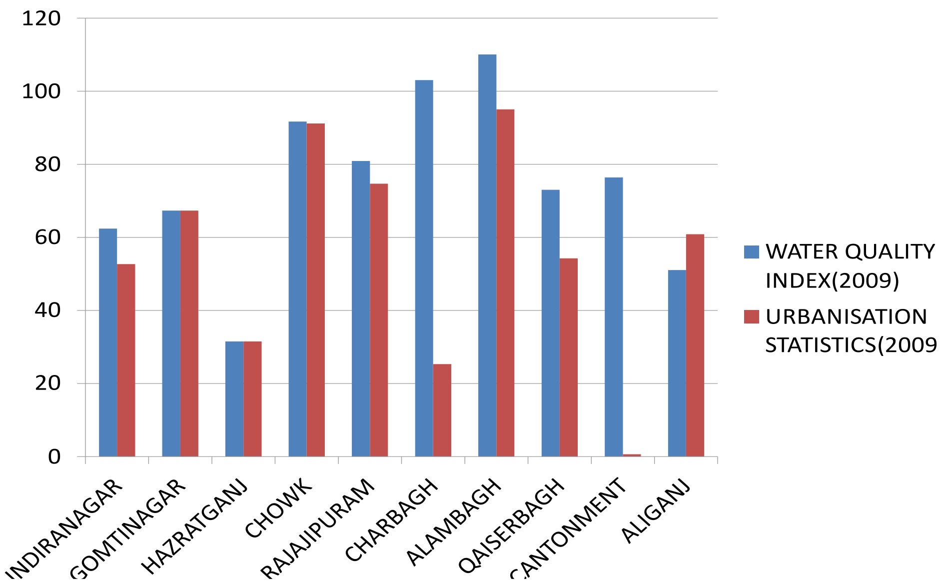


Fig. 4.7 Water quality index (2009)

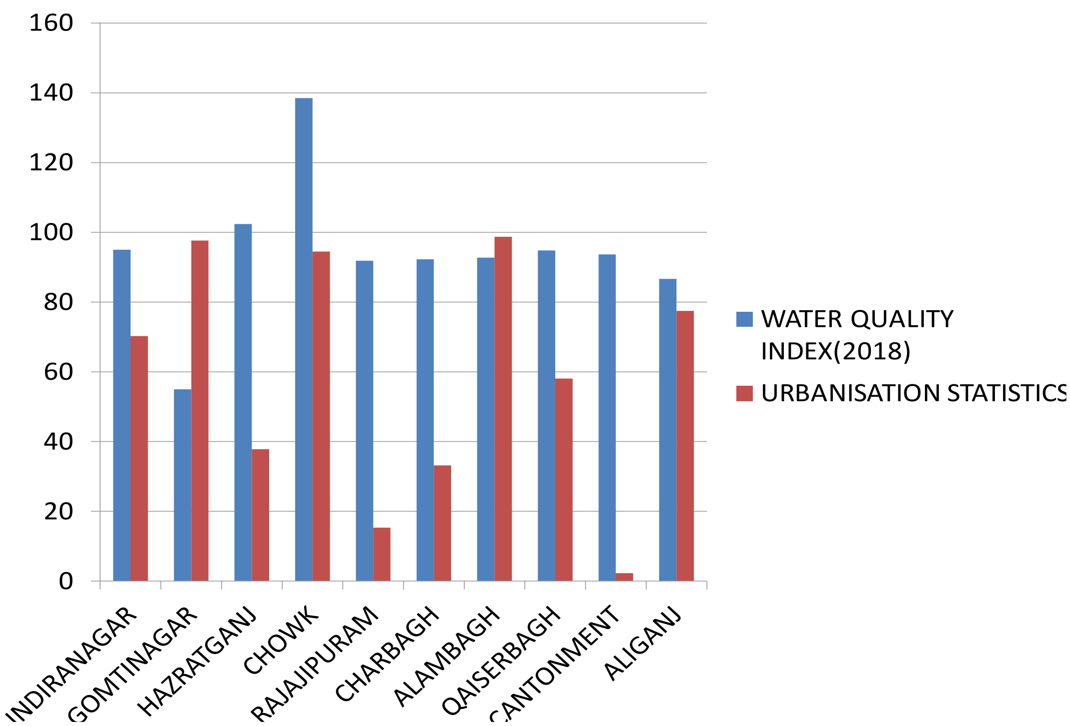


Fig. 4.7 Water quality index (2018)

Table 4.10 Water Quality Index

Water quality Index	**Category**
0-25	Excellent
26-50	Good
51-75	Poor
76-100	Very Poor
> 100	Unfit for Drinking (UFD)

X. CONCLUSION

On the basis of above discussion, it may be concluded that underground water quality in the study area isshowing high correlation with the land use. The drinking water is highly polluted in the residential areas with high population density. The water quality of Sub urban areas having less population density and build up area are having comparatively better quality of water. Samples of suburban areas which are in close vicinity of the city like Chowk, Rajajipuram, Aliganj, Munsipulia Indira Nagar, Gomtinagar, Charbagh etc. are showing poor quality of water. Therefore, some effective measures are urgently required to enhance the drinking water quality by an effective management plan. The domain of the study focuses that if proper planning and measures are not taken then in the near future this will engulf the outskirts of the city where at present the water quality is still good.

Future scope

- Sample collection may be done for a broader perspective area to cover the lucknow district boundary.
- Physio chemical testing of the collected field sample may be done on more no. of parameters of water Quality like Mg, Na, Iron content, Ca, BOD, COD.

Limitation

- Actual figures of urban growth is difficult to predict as there exist a lag period of updation& revision of urbangrowth data on the software.

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