

# Spatial Distribution of Physical And Chemical Parameters of Water in Lucknow District

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**ABSTRACT:** This paper presents the Spatial variation of groundwater quality parameter such as pH, TDS, Salinity, EC and Hardness of water were carried out through GIS and geo statistical techniques. IDW (Inverse distance Weighted) was used to obtain the spatial distribution of ground water quality parameters over the area. Contour maps, showing the distribution of TDS across the district area as measured during summer, 2015 was prepared. Total dissolved solids (TDS) level in groundwater ranged between 131.1 ppm and to 1752 ppm Out of 76 water samples analysed, the concentration levels of 51 samples were found to be within the desirable limit (500 ppm) whereas the levels in remaining 25 samples exceeded the desirable limit for TDS in drinking water as per Indian standards (BIS-10500 1991) , 500. TDS greater than 500 renders water unpalatable. These high TDS sampling stations are mostly distributed in the centre and north-eastern part of the study area, having a high density of population.

**KEYWORDS-**Physical-Chemical Parameters, Lucknow District Ground Water, Arc GIS 9.3

## 1.0 INTRODUCTION

The Geographical Information System (GIS) has emerged as an effective tool for analyzing the vast volumes of different data types, obtained from different sources. It is being used to manage environmental, climatic and hydrological data to support decision making and meet regulatory requirements. GIS was used to help in understanding the spatial variations of the concentrations of the physical and chemical parameters.

The Gomti originates from Gomat Taal which was formally known as Fulhaar Jheel near MadhoTanda, Pilibhit, India. It extends to 900 km through Uttar Pradesh and meets the Ganges River near Saidpur Kaithi in Gazipur. Its water coverage is about 22,735 square km. After travelling about 240 km Gomti

enters Lucknow, where it travels for 16 km. The cities of Lucknow, Lakhimpur Kheri, Sultanpur and Jaunpur are located on the banks of the Gomti and are the most prominent of the 15 towns located in its catchment area. Its flow mainly depends upon occurrence of rain and therefore the flow in river is very lenient during monsoon. The river collects large amounts of human and industrial pollutants as it flows through the highly populous areas (18 million approx) of Uttar Pradesh. High pollution levels in the river have negative effects on the ecosystem of the Gomti threatening its aquatic life. Before reaching in Lucknow Gomti receives waste from sugar and distillery industries of Sitapur. All industries of distillery, milk industry,

vegetable oil, pouring effluent directly into Gomti and besides this domestic

waste water are also discharge into the river Gomti.

## 2.0 METHODOLOGY:

The present project work has been accomplished by carrying out the following studies that have been broadly subdivided into three parts, namely

- 1-Field studies
- 2- Laboratory Analysis
- 3- GIS Analysis

### 2.1 Field studies

Water Samples were collected from 76 sampling sites representing the four Tehsils of Lucknow district, during the summer's months of April and May, 2015 from shallow hand pumps, dug -wells, tube wells, bore well and rivers. These water samples were collected in two sets from different stations and stored in acid – cleaned, high density polyethylene (HDPE) bottles. The use of (HDPE) bottles minimizes container pollution and promotes sample preservation (Hall, 1988). Water was discharged from the sample well / hand pump for 2 to 3 minutes and the container washed with same water 2 to 3 times before collecting the water in the bottles. These bottles were taken to the lab and the analysis of the water samples was carried out immediately after collection. Spatial coordinates of the sampling points were measured on site using a hand held GPS instrument GARMIN "eTrex+". The hand held GPS instruments are time saving and cost effective when compared to the traditional surveying equipments and techniques. Various attributes of the sampling wells were collected on site including well type, depth of well and location.

### 2.2 Laboratory Analysis

The non- conservative and physical parameters (pH, Temp, EC, TDS and Salinity) were measured in situ with

their respective probes to measure the concentrations of the different water quality parameters. Bicarbonate ( $\text{HCO}_3$ ) was analyzed in the laboratory using the Titration methods.

**2.2.1 Total Suspended Solids (TSS)** were estimated by gravimetric method. The evaporating dish was dried at  $104 \pm 10^\circ\text{C}$  for 1 h and cooled in desiccators to take the weight of the dish. 25 ml of the sample was taken for the analysis in a pre-dried dish and was evaporated to dryness in an oven at  $104 \pm 10^\circ\text{C}$ . The dish was cooled in desiccators and final weight was taken for the analysis of TSS content.

Total Dissolved Solids (TDS) was also determined by estimated by Gravimetric method.

### 2.2.2 Dissolved Oxygen (DO):

Dissolved oxygen content of the water samples was measured by using Winkler's method (modified azide method). The sample was collected in 300 ml bottle and DO was fixed on site by using 1 ml each of Manganous sulphate and Alkaline-iodide-azide. The precipitate formed was dissolved in laboratory by using sulphuric acid and titrated with sodium thiosulphate using starch as an indicator. The end point of titration was blue to straw pale colour.

$$\text{DO (mg/L)} = \frac{\text{ml of titrant} \times N \times 1000 \times 8}{V_2(V_1 - V_2)V_1}$$

**2.2.3 pH:** pH was determined using the standard pH meter. The pH electrode was dipped in the solution and pH was recorded after every 4 days.

**2.2.4 Hardness:** The total hardness of the water samples was determined by EDTA titration method where 50 ml of well mixed sample was mixed with 1-2 ml buffer of pH 10 and a pinch of Eriochrome black-T indicator. The contents were then titrated with 0.01M



EDTA till wine red solution changes to blue.

$$\text{Hardness (mg/L)} = \frac{C \times D \times 1000}{\text{ml of Sample}}$$

Where C=ml of EDTA for titration, D= mg of CaCO<sub>3</sub> equivalent to 1ml of EDTA

**2.3 GIS Analysis:**

For GIS studies different software’s were used for preparation of different thematic map namely:

- Mapping and modelling software: ARC GIS 9.3.
- Map composition: ARC INFO.

**2.3.1 Process:**

First the digital copies of topographical maps of Lucknow and adjoining areas (Survey of India) were obtained from the Geology department of Lucknow University. These maps were georeferenced, WGS 1984 projection system applied and images clipped to remove excess area. Subsequently these nine topographical maps (Table 1) were mosaiced and a topographical map showing the entire Lucknow region was obtained.

The location of wells, 76 in number was obtained using a hand held GPS receiver. The data of geochemical analysis of water obtained from these location points was converted into an excel sheet and this sheet was added as a layer in Arc GIS 9.3.

S.No	Survey of India Toposheet no.	Scale
1.	63B/9, 10, 13, 14	1:50,000
2.	63F/1,2	1:50,000
3.	63 A/ 12,16	1:50,000
4.	63 E/ 4	1:50,000

**Table -1 Topographical Data**

**Geographic data types used:**

Spatial Maps model geographic features on the earth using points, lines and polygons.

**Point data:** The spatial coordinates of the location points were acquired using the above sheet.

**Line data:** The Gomati, Behta and Loni rivers were digitized and these linear features were represented on the study area map using Arc Catalog. **Polygon data:** Lucknow district and Tehsil boundaries were digitized using Arc Catalog.

**Database creation:** A database is an organized collection of data. Two types of databases were created namely: Spatial database and Attribute database.

**Spatial Database:** Spatial database contains the absolute and relative location of geographic features. The spatial database was prepared by different thematic layers like base map of study area, drainage network, district, and Tehsil boundaries from GOI toposheets on 1:50,000 scale using Arc info GIS software to obtain base line data. GOI toposheet, GPS data was used together with ground truth data.

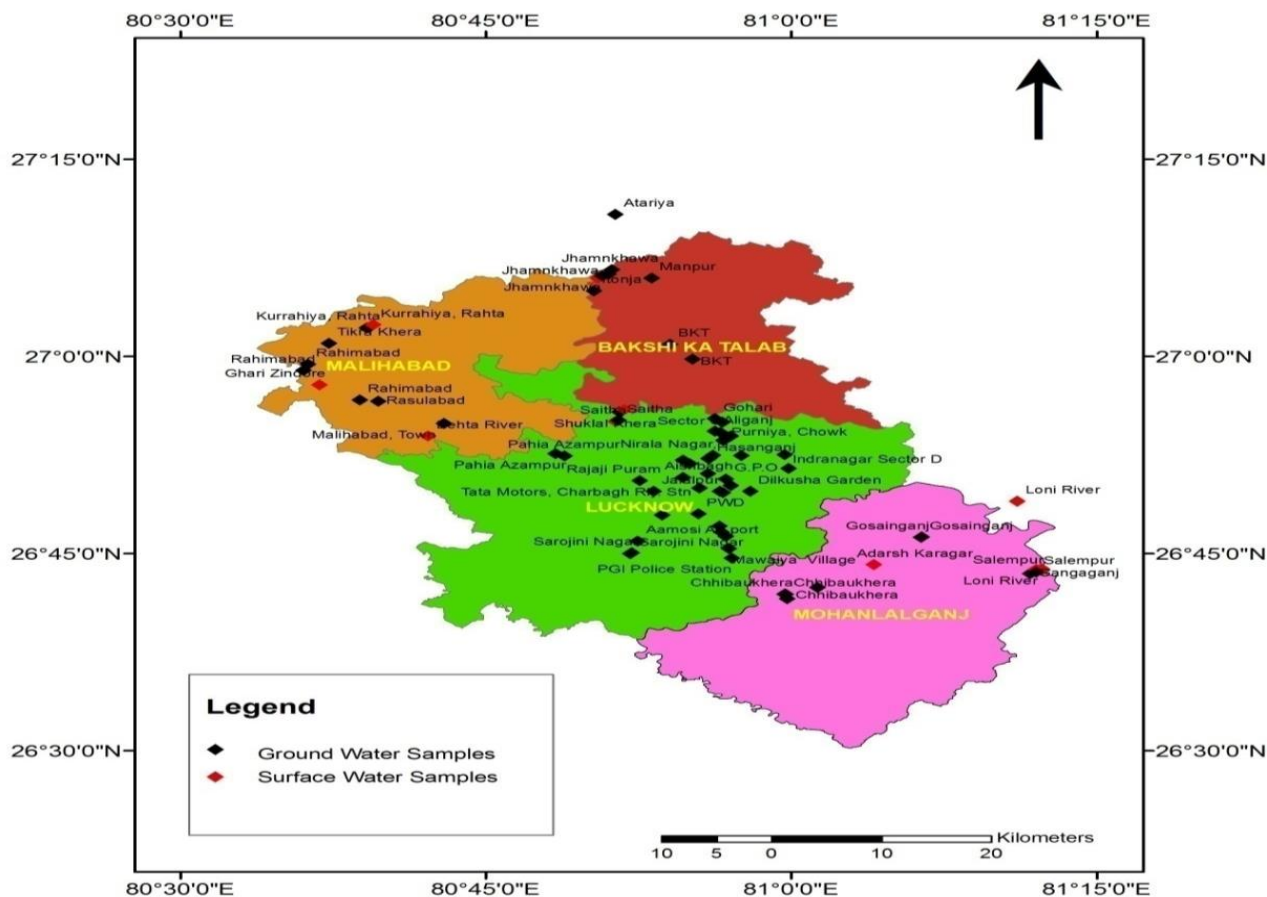
**Attribute Database:** Attribute database contains quantitative or qualitative characteristics or attributes of the spatial features. Groundwater samples were collected from different locations and analyzed for five water quality physico- chemical parameters. The data thus obtained was used as a database for the present study.

**Geostatistical Method Applied:** Spatial interpolation creates a surface that models sampled phenomenons in the best possible way. It calculates unknown values from a set of sample points with know values that are distributed across an area. The distance from the cells to the samples cells contributes to its final value estimation. For spatial interpolation of the water quality parameters the present study uses the IDW method. **Inverse distance**

Weighted (IDW) method considers the spatial autocorrelation between the sample points and is mostly used for mapping spatial variability. It assumes that the nearer a sample point is to the

cell whose value estimated the more closely the cell's value will resemble the sample point's value.

Location of Water Samples



Map: This map is developed from Arc GIS 9.3 software from the data collected

Spot	Village Name	Y Coordinates	X Coordinates	TDS (ppm)	EC (µS/cm)	Salinity	HCO <sub>3</sub> (mg/l)	PH	Temp (°C)
1	Chhibaukhera	26.6930556	80.9966389	343	529	391	280.2	7.3	33.5°
2	Chhibaukhera	26.6986667	80.9945833	351	545	402	242	7.4	33.6°
3	Chhibaukhera	26.6986667	80.9951389	325	480	373	256.4	7.3	32.7°
4	SarswatiPuram	26.7071111	81.0213889	347	520	395	268.5	7.4	32.3°
5	AdarshKaragar	26.7361111	81.0674722	168	240	195	134.6	7.1	32.7°
6	Gosainganj	26.7708056	81.1062222	337	526	387	231.6	7.5	32.8°
7	Gosainganj	26.7710833	81.1066111	402	656	465	256.4	7.4	32.2°
8	Loni River	26.8165833	81.1848056	232	342	264	195.5	7.3	32.8°
9	Gangaganj	26.7246944	81.1953056	774	1945	892	484	7.6	32.2°
10	Salempur	26.7279444	81.1985556	1355	2050	1563	362	7.4	31.3°
11	Gomti River	26.7310833	81.2048056	355	530	405	246	7.1	32.7°
12	Gomti+Loni rive	26.7291389	81.2050833	295	455	343	176.8	7.2	31.2°
13	Loni River	26.7302222	81.2001389	197	275	225	137.2	7.3	31.6°
14	Salempur	26.7268333	81.2000556	425	642	483	315.2	7.2	31.2°
15	BKT	26.9968333	80.9190833	364	547	415	335	7.2	34.3°
16	BKT	27.0154722	80.9005	333	527	397	253.2	7.4	34.7°
17	Itonja	27.08325	80.83825	315	488	365	234	7.5	34.4°
18	Jhamnkhawa	27.1041944	80.8500833	366	555	414	294.8	7.4	34.2°
19	Gomti River	27.0993889	80.8416667	285	435	323	194.2	7.3	34.7°
20	Jhamnkhawa	27.1023889	80.8452778	473	715	543	324.4	7.3	34.2°

21	Atariya	27.1802778	80.8558056	328	495	373	284.6	7.4	34.3°
22	Jhamkhawa	27.1100278	80.8530833	414	645	482	314.2	7.6	34.2°
23	Manpur	27.0995	80.8854167	266	398	303	533.8	7.4	34.4°
24	Gohari	26.9211111	80.9374444	885	1347	1012	412.8	7.5	34.2°
25	Pahia Azampur	26.8769167	80.8068333	343	519	392	287.6	7.3	33.2°
26	Pahia Azampur	26.8740556	80.8141389	324	550	382	257.2	7.5	33.4°
27	Saitha	26.9176111	80.8563333	131.4	255	151.5	182	7.2	33.2°
28	Saitha	26.9191111	80.8583611	354	521	403	351	7.4	33.4
29	Shuklal Khera	26.9298611	80.8592222	393	649	452	285.6	7.1	34.2°
30	Shuklal Khera	26.9298889	80.85925	203	324	244	152.6	7.3	34.1°
31	Shuklal Khera	26.9295	80.8598889	522	809	614	353.8	7.4	34.1°
32	Gomti River	26.9327222	80.8629444	737	1133	855	437	7.3	34.7°
33	Rasulabad	26.9432778	80.6616389	363	541	416	345	7.3	34.2°
34	Rahimabad	26.945	80.6466944	276	478	312	448	7.4	34.7°
35	Ghari Zindore	26.9640556	80.6138611	603	974	692	345	7.5	34.2°
36	Rahimabad	26.98225	80.6005278	366	545	422	252.2	7.3	34.6°
37	Rahimabad	26.9901389	80.6042778	563	829	631	263.4	7.5	34.2°
38	Tikra Khera	27.01675	80.6214444	286	435	324	233.8	7.4	34.6°
39	Kurrahiya, Rahta	27.0363333	80.6523611	433	666	504	336	7.4	33.2°
40	Kurrahiya, Rahta	27.0365833	80.6541111	327	498	374	264.4	7.6	34.6°
41	Kurrahiya, Rahta	27.0401389	80.6575278	314	479	358	153	7.7	34.2°
42	Malihabad, Town	26.9151944	80.7154722	675	1043	786	365	7.3	34.6°
43	Behta River	26.8991389	80.7024722	294	454	343	267.4	7.4	34.2°
44	PGI Police St.	26.7445556	80.9512778	344	532	396	288.6	7.5	34.6°
45	Mawaiya Village	26.7565833	80.94875	364	555	414	288.6	7.4	33.2°
46	Irrigation Dept.	26.7772778	80.9425	333	513	382	258.2	7.3	34.6°
47	A.S.P. College, Near South City	26.7721389	80.9464722	307	478	351	237.8	7.5	34.3°
48	Human Mandir, Telibag	26.7852778	80.9409722	493	764	572	265.4	7.7	34.2°
49	Amausi Air port	26.7661389	80.874222	705	1071	812	354.8	7.5	34.7°
50	Sarojini Nagar	26.7511944	80.8690833	496	760	571	393.4	7.4	33.2°
51	Sarojini Nagar	26.75	80.8682222	404	621	461	342.6	7.3	33.4°
52	Chanakyapuri, Barah Briwa	26.7989444	80.8940556	513	797	595	336	7.6	33.5°
53	PWD	26.8004167	80.92375	453	704	535	292.8	7.4	33.5°
54	Aishbagh	26.8468611	80.9113889	362	554	423	262.4	7.6	33.3°
55	Nibu park, Chowk	26.8688333	80.9113889	676	1037	782	284.6	7.5	33.3°
56	Medical College	26.8643889	80.9165556	625	900	723	325.4	7.4	33.2°
57	Kaisarbag	26.8515	80.931611	578	889	666	253.2	7.4	33.2°
58	Rajaji Puram	26.8426111	80.8759444	473	720	545	344.6	7.7	34.3°
59	Jalalpur	26.8290556	80.887	437	665	504	353.8	7.6	34.4°
60	Aliganj	26.9052778	80.9373611	646	987	744	346.6	7.3	33.7°
61	Sector Q	26.90375	80.9416389	372	584	433	287.6	7.4	33.2°
62	Beligarad Chowk	26.8990833	80.9505556	806	1238	922	467.6	7.3	33.7°
63	Purniya, Chowk	26.8935556	80.9441667	633	972	732	373.2	7.6	33.4°
64	Mahanagar, Golmarket	26.8743611	80.9588056	632	974	734	415.8	7.3	33.3°
65	Nirala Nagar,	26.8746389	80.9358333	364	565	423	214.6	7.6	34.8°
66	Gomti Nagar, Vivek Khand	26.8581111	80.9975556	363	486	363	237.8	7.4	34.3°
67	Indranagar Sector D	26.8756111	80.9945	1752	267	202	154.6	7.3	34.5°
68	Engg. College, Janikipuram	26.9166889	80.9434722	321	494	363	235.8	7.4	34.2°
69	G. N. Mishra	26.8707778	80.9321667	833	1284	966	153.6	7.5	36.4°



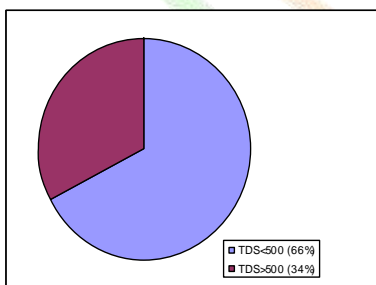
	Park, Hasanganj								
70	Hasanganj	26.8705833	80.9325	702	1073	813	175.8	7.4	36.7°
71	Hata Ram Das, Sadar	26.82925	80.9414167	574	887	663	293.8	7.6	34.5°
72	Pump House No.1 Cantt Board, Sadar	26.8275556	80.9438056	533	853	642	376.2	7.6	34.3°
73	Tata Motors, Charbagh Rly. Stn	26.8331111	80.9248889	502	773	582	335	7.7	36.5°
74	Dilkusha Garden	26.8289444	80.9662778	502	786	584	403.6	7.2	36.2°
75	Opp. Loreto Convent	26.8362778	80.9505	422	652	494	355.8	7.4	36.5°
76	G.P.O	26.84475	80.9462222	615	943	715	393.4	7.3	36.2°

**Table 2: Concentration of water quality parameters**

**4.0 CONCLUSION:**

Total dissolved solids (TDS) level in groundwater ranged between 131.1 ppm and to 1752 ppm Out of 76 water samples analysed, the concentration levels of 51 samples were found to be within the desirable limit (500 ppm) whereas the levels in remaining 25 samples exceeded the desirable limit for TDS in drinking water as per Indian standards (BIS-10500 1991) , 500. TDS greater than 500 renders water unpalatable. These high TDS sampling stations are mostly distributed in the centre and northeastern part of the study area, having a high density of population.

**Pie chart showing the percentage of samples lying within the BIS range and those lying outside of it. (TDS)**



WHO recommends a limit of 1000 ppm. It observed that TDS in water from Salempur and Indranagar are above the desirable

limit prescribed by WHO and run into brackish water.

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