ANALYSIS SPATIAL DISTRIBUTION OF GROUND WATER ATTRIBUTES IN MULTAN DISTRICT PUNJAB PAKISTAN

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ABSTRACT

Water is important for life and most of the household usage of water is completed by the groundwater. The determination of this study is to assess the pollutions of groundwater based on the presence of different components in the groundwater. The ground water samples were collected from seventy different locations in six different cities; Multan, Vehari, Khanewal, Sahiwal, Pakpattan, and Lodhran. All the analysis of the collected water samples were performed in Pure Solution Lab. Faisalabad. Eleven parameters, pH, total hardness, calcium, magnesium, chloride, TDS, turbidity, Sulfate, Sodium, Potassium and Nitrite, were assessed to estimate the quality of groundwater. The quantity of those physicochemical parameters was assessed using multiple analytical methods. To assess the spatial distribution of those eleven parameters in six different cities of district of Multan, the Inverse Distance Weighted (IDW) technique was implemented popular ArcGIS v 10.0 software. The results showed that the on the basis of hardness, more than 50% of the region has unfit ground water. The pH assessment of these samples remained in the allowed range i.e. 6.5-8.5.The total suspended solids concentration ranged from 3661.75 to 3790.25 mg/L, which was greater than the standard value of 1000 mg/L. The nitrate focus (0.126 to 8.74 ppm) also between the WHO permissible limit (50ppm). The chloride concentration ranged between (38.04-463.413ppm), which was higher than the WHO standard value of (250ppm). Calcium concentrations ranging from 40.93 to 198.6 ppm and sodium concentrations ranging from 28.59 to 661.82 ppm were also within WHO's permissible limits (50 ppm). Overall, the results showed that most of the parameters had higher values than the standards, indicating that sewage waste water was negatively moving the quality of drinking water. IDW predicted

the most contaminated region of different cities of district Multan. The results indicate that the aquifer water in all of the investigated locations is unsafe for consumption and for household applications, as the majority of the evaluated parameters defected from the WHO criteria. According to the research, drinking contaminated groundwater is dangerous, and installing water filter plants throughout all rural regions is urgently needed to satisfy with government health-related standards.

Keywords: Inverse distance weighted, maps, drinking water source, sampling, groundwater quality maps, physico-chemical characteristics.

INTRODUCTION

Groundwater is an essential resource that is important to both the preservation of aquatic and Environmental ecosystems as well as the existence of human civilizations. However, as a result of increasing population and the expansion of agricultural areas, groundwater resources are under more strain, which has resulted in overuse and a reduction in water quality. Pakistan was created in an ecosystem with rich surface and groundwater resources.

Water assets are under tremendous demand due to economic expansion, population increase, and rapid economic development (Aziz, 2002). Water consumption plays a dynamic role in our survival-time developments, which account for evolution as well as advancement. It demonstrates how crucial a role it plays in every stage of our lifespan. Water contamination is a physical process that occurs in many different types of water environments, such oceans, groundwater, and canals, as a result of anthropogenic activities. It was necessary to make the water safe for drinking decisions when it moved away from apparent water qualities (Soomro, Khokhar, Hussain, & Hussain, 2011).

The biological environment still has the highest levels of hazardous pollution, which can have fatal consequences for human health. There is a common practice to label water consumption as safe and to minimize prevalent illnesses (Patoli, Patoli, & Mehraj, 2010). Water that is fit for drinking must be free of pathogens, turbidity, smell, and shadow. It needs to be aesthetically pleasant. Unclean water continues to be the most upsetting misbehavior toward Multan's general people. In Pakistan right now, there is around 79 percent water available (Moe, Sobsey, Samsa, & Mesolo, 1991).

A high level of fitness risk is presented to the community just before the community when inadequate as well as low water quantity for intakes drive. In certain areas of the country, the issue of contaminated groundwater is now so bad that complete groundwater properties might be destroyed if crucial ladders are not used. Different ground waters include different types of salts that fail the earth as a result. They are soil depths of despair. The desert and semi-dry areas of the world have an important portion of this problem.

MATERIAL AND METHODS

3.1 Study Site

The study was conducted in Multan City. The city, which is situated among 29° 19′ 11″ as well as 30° 28′ 16″ latitude, is the 5th most populous in the nation. N, and from latitudes 70° 58′ 34″ regarding 71° 43′ 25″. A significant city in South the Punjab region is Multan. The city experiences hotter summers and milder winters due to its arid climate. The highest and lowest recorded temperatures in the city were 54 °C (129 °F) and 1 °C (30 °F), Extreme weather conditions prevailed accordingly (Batool et al., 2018).

Multan City, Sahiwal, Vehari, Pakpattan, Khanewal, and Lodhran are the five divisions that make up this region. A total of 5 cities, Khanewal, Lodhran, Sahiwal, Vehari, and Pakpattan, were selected for sampling out of the five divisions in the District of Multan (Figure 3.1).

Figure 3.1: *The study site of district Multan*

3.2 Collection of Water Samples

Polluted water has become a serious issue in the Multan District, where homes pump underground water through holes in the ground for water sources, due to the lack of oversight of drinking tap water. collected samples of water from the city of Multan's ten different locations, including tube wells, water supplies, and hand pumps.10 different sites were sampled, including Khanewal, Lodhran, Sahiwal, Vehari, and Pakpattan. 70 samples altogether were gathered. Not any single source was providing clean water for people to drink in any of these seventy locations. These samples' physical-chemical analysis revealed that they exceeded the WHO's permitted values for hardness, calcium, magnesium, calcium, along with sulphate (Poli, Aparna, & Motireddy, 2022).

Each sample was subjected to multiple water quality tests in the pure solution lab. The results of the water samples demonstrated that the community's supply of water was not only dangerous to drink but also the source of numerous acute illnesses, such as hepatitis-C, gastroenteritis, and others. As a result, the focus of this research is on the detailed examination of groundwater samples for a variety of physical and chemical variables as well as the spatial distribution of those water quality parameters using the inverse-distance-weighted [IDW] an interpolation technique. This is done with the stark findings of the research and the WHO notifications in mind (Worako et al., 2015).

3.3 Analysis

According to the collection procedure, groundwater samples were taken from a total of five cities, such as Multan City, in the District of Multan. Some of the variables that were assessed in the lab included chlorides, temperature, color, odor, turbidity, total dissolved solids (TDS), nitrate, sulphate, and hydrogen ions concentration (pH). They were examined for 11 different factors, including hardness, calcium, magnesium, and chloride using the titration method, taste, color, and odor using the six senses, pH and total dissolved solids (TDS) using a pH meter and TDS meter, and turbidity using a nephelometer. Nitrite and sulfate concentrations were measured using a spectrophotometer. A flame photometer is used to measure sodium and potassium (Nisa el al., 2020).

3.4 Spatial distribution Analysis through Geographical Information Systems (GIS)

Samples taken from specific locations of existing water wells were used to create the water quality maps and other supporting maps. The water data and sampling locations were combined to produce spatial distribution diagrams of specific water qualities. Here, the spatial calculation of water pollutants or other parameters in the Multan district was done using the Inverse displacement weighted (IDW) method.

With the help of a predetermined or defined set of sample points, this method calculates the value of the resulting grid cell. By calculating coordinates using a gradually weighted collection of a number of sample points and regulating the importance of known a point on the values that were interpolated based on their distances from the output point, it produces both a surface pattern and thematic results. Utilizing mapping techniques, significant water quality parameters and their location in space designs in Multan were additionally examined. As a result of this, the technologies enable us to illustrate the causal chain in a visual manner (Basharat et al., 2012).

3.5 Chemicals

Distilled water, Chloride titrant (AgNO3), Chloride indicator (K2CrO4), Hardness buffer (NH4Cl),Calcium buffer (NaOH), Calcium indicator (Murexide), Sulphate turbidity reagent (Germany), Hardness indicator (Erichrome black T), Free Chlorine reagent, Nitrite reagents, Hardness titrant (EDTA), Standard potassium and sodium solutions, and ethanol .

3.6 Equipment

Beakers, Graduated Cylinders, Incubator, pH meter, Flame Photometer, Spectrophotometer, Iron Stand, Dropping Pipettes, Flask, Stirrer Digital Balance, Glass filtration membrane assembly, acid burette Forceps, Petri dishes, a magnifying glass, a membrane filter, a mask, and disposable gloves.

3.7 Chemical Analysis

3.7.1 Physico-Chemical tests

3.7.1.1 Appearance

Shake the sample thoroughly, look for any foreign or suspended particles, and report anything found.

3.7.1.2 Color, Odor and Taste Analysis

Color, odors, taste was checked by sensory assessment.

3.7.1.3 pH Analysis

Measured the pH after calibrating the pH meter.

3.7.1.4 T.D.S (Total dissolve solids) Analysis

Noted the T.D.S. after calibrating the T.D.S. meter

3.7.1.5 Total Hardness Analysis

Added 05 a drop of hardness buffering agent and a few milligrams of hardness indicator to a 50 ml sample in the titration flask. Titrate it in opposition to the Hardness Titrant. As permitted by the WHO, the color of the final product goes from purple to sky blue. Take note of the amount of Hardness Titrant used.

Total Hardness as CaCO3 (ppm) Calculation: Volume Used × 20

3.7.1.6 Calcium (Ca) Analysis

Added 05 a drop of calcium buffering and a few milligrams of calcium indicator to a 50 ml sample in a titration flask. If you test it against hardness, the solution's color will change from pink to purple as it shakes. I took note of the amount of Hardness Titrant that was utilized, as allowed by the WHO.

Total the hardness as CaCO3 (ppm) Calculation: Volume Used× 8.02

3.7.1.7 Magnesium (Mg) Analysis

By Calcium and Hardness Difference.

Calculation: Calcium Hardness Burette is Reading - Total Hardness Burette is Reading × 4.86 to calculate magnesium (ppm).

3.7.1.8 Chloride (Cl) Analysis

Added a few crystals of the chloride indicator to the 50 ml sample that was placed in the titration flask. Defend it from chloride Defend it with Chloride Titrant. The solution's color will transition in yellow to brick like red. I took note of the amount of chloride the titrant used, as allowed by the WHO.

Calculation

Volume Used ×20 = Chloride (ppm)

3.7.1.9 Sulphate (SO_4) Analysis

According to permitted by the WHO, Set the photometer's wavelength to 525 nm and the reading to 100 after inserting the photometer cell that included distilled water. Add 05 drops of the Sulphate Turbidity Reagent to the 25 ml sample, then place the sample in the second photometer cell. Record the readings, noting any differences.

Sulphate (ppm) calculation=reading difference ×0.5

3.7.1.10 Nitrite (NO_2) Analysis

In accordance with the WHO's permission, A photometer cell with distilled water was inserted, the photometer's wavelength was set to 410 nm, and the reading was set to 100. Put 25 ml of the sample within the second photometer cell with five drops of the nitrite reagent, and then take the reading. Keep in mind the reading's difference.

Reading difference× 0.01 to calculate nitrite (ppm).

3.7.1.11 Free Chlorine (Cl_2) Analysis

According to permitted by the WHO, Set the photometer's wavelength to 410 nm and the reading to 100 after inserting a measuring cell containing distilled water. 25 ml of sample should contain a total of five drops of chlorine-based reagent. Place the sample within the second photometer cell, and then read the reading. Take note of the reading's variation.

Calculation

Free chlorine (ppm) = Difference in reading× 0.1

3.7.1.12 Sodium (Na) Analysis

Took distilled water in a beaker, started the flame photometer, compressor, gas carefully, then pressed the ignition and adjusted the flame to a reasonable level. Set value 00 with the distilled water, then swap it out for a sodium standard solution and set value 50. After waiting a minute, replace out the sample for the Na standard solution, and the result is displayed, as allowed by the WHO.

3.7.1.13 Potassium (K) Analysis

Took distilled water in a beaker, started the flame photometer, compressor, gas carefully, then pressed the ignition and adjusted the flame to a reasonable level. Set value 00 in distilled water, replace it with potassium standard solution and set value 10, wait one minute, and then exchange the sample for the potassium standard solution. The displayed result is K value, as permitted by the WHO.

RESULTS AND DISCUSSION

4.1 Concentration of Hydrogen Ions (pH)

Spatial distribution about ground water pH in Multan District was shown in Figure 4.1. pH values range from 6.45 to 7.85. The pH ranges from 6.4 to 9.96. The districts of Lodhran and central Multan had the lowest pH readings. Sahiwal region pH levels were found to be higher.

Additionally, the ranges of 8.02 to 8.4 were determined for the expected results of ground water samples in Pakpattan City, the Eastern Place of Sahiwal, as well as certain areas of Vehari, Khanewal, Multan, and Lodhran. For ideal water clarity and cleanliness, each stage of the water treatment method requires precise pH management.

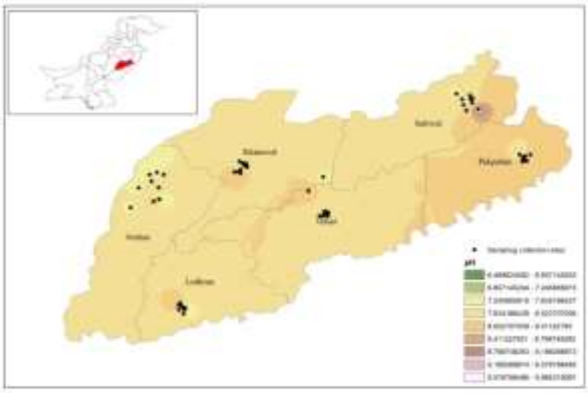

Figure 4.1: Multan District's pH spatial distribution.

4.2 Turbidity

The high turbidity of the liquid (0.5 NTU) of the research field may be spatially evaluated across the entire study area, as shown in Figure 4.2, which depicts the turbidity. The remainder of the sample locations, mostly in Multan's northeast and northwest, Khanewal, Lodhran, and Pakpattan, had turbidity levels below (0.5 NTU). Spatial distribution of ground water turbidity values is depicted in figure 4.1. The turbidity values range from 0.5 NTU. The areas with the highest turbidity readings were Vehari, Sahiwal, and central Multan. In the regions of Multan, Khanewal, Pakpattan, and Lodhran, lower turbidity values were found (Basharat el al., 2012).

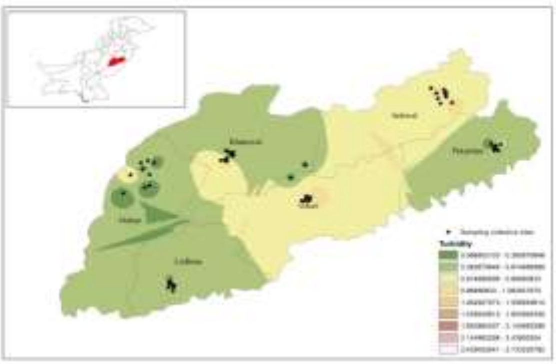

Figure 4.2: *Different turbidity concentrations in ground water distributed spatially. Nephelometric Turbidity Unit (NTU) is the unit used to express concentration.*

4.3 Total Dissolved Solids (TDS)

The term "solids" refers to the dissolved or suspended particles in water (Mahmood et al., 2021). There are many ways that solids can impair the quality of water. A the total dissolved solid concentration below 400 mg/L is considered excellent, within four hundred and seven hundred mg/L is considered acceptable, and over 700 mg/L is not considered suitable for drinking, according to the WHO. The spatial distribution of the the total dissolved solid across the entire study area is depicted in great detail in Figure 4.3.

While there are locations with water that has a TDS value over 1000 mg/L in the north and south-east as well, the south and southeast have a wider spatial distribution. The deeper layer of soil contains salt, and there has been prolonged ground water interaction with the aquifer body. These factors could be to blame for the higher the total dissolved solid level. Short-term users of high TDS drinking water may experience digestive issues as well as serious physiological reactions(Mahmood et al., 2021).

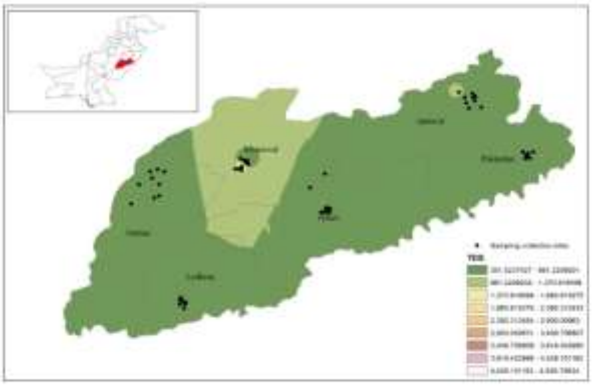

Figure 4.3: *Total dissolved salts (TDS) concentrations at various locations (parts per million) in groundwater.*

Spatial distribution of ground water's TDS values is depicted in figure 4.3. The samples' values range from 351 ppm to 2900 ppm, and have a maximum of 500 ppm. In the regions of Multan, Lodhran Vehari, Pakpattan, and Sahiwal, the values below the range were found. Greater TDS levels were found in the Khanewal and central Sahiwal regions.

4.4 Chloride

The ideal level of chloride is less than 250 mg/L because water loses flavor at concentrations higher than that. The water in every one of the sample places had acceptable chloride levels (>250 mg/L), as determined by the WHO. Figure 4.4 illustrates this.

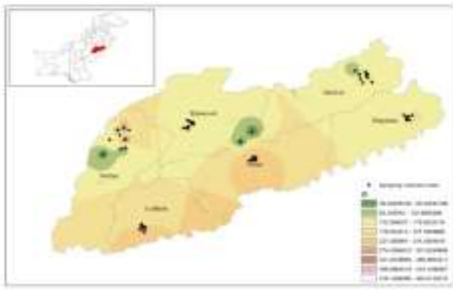

Figure 4.4: *Different Chloride (Cl) concentrations (in parts per million) are distributed spatially in groundwater.*

Spatial distribution about ground water's Cl values is depicted in figure 4.4. Cl values have a range of 250 mg/L. The regions of Sahiwal, Khanewal, and central Multan showed the lowest Cl values. In the regions of Vehari and Lodhran, moderate levels of Cl were found. Higher values were found in some Multan and Lodhran location locations.

4.5 Concentration of Ca Ions in Ground Water

It is important to measure the amount of calcium ions present in ground water. For the structure of plants, shells, and bones as well as to plant and animal nutrition, calcium is crucial. The existence of calcium in drinking water is brought on by the movement of limestone, is a dolomite, cement, and shale deposits. The absolute maximum concentration of calcium in the earth is between 75 and 100 mg/L, but less than 75 mg/L is the ideal level. A majority of Asian countries' drinking water contains among 2 as well as 80 mg/L of calcium, according to research.

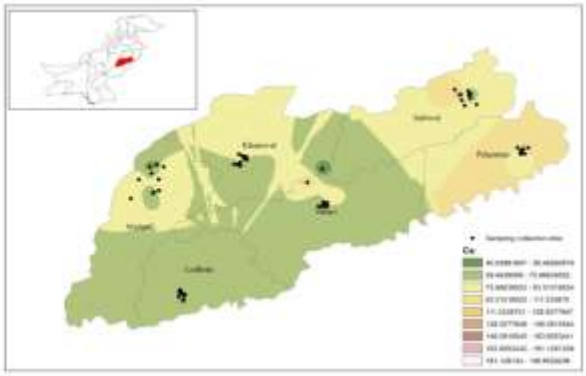

***Figure 4.5:** Different calcium (Ca) concentrations (in parts per million) are spatially distributed in groundwater.*

4.6 Concentration of Mg Ions in Ground Water

It was discovered that the water tested at the sites Khanewal and Vehari contained Mg inside its lowest or most desirable range [12-50 mg/L], as depicted in green on Figure 4.6. However, as indicated by pink spots, the sample the location in the south-east shows Mg levels that fall within the fifty to 150 mg/L highest permissible or allowable range. The allowed Mg level has only been exceeded in a small number of sample places, some of that are located in the southeast for the research region in Multan (Ali et al, 2019).

The spatial distribution about ground water's Mg values is depicted in figure 4.6. The Mg values range from 50 mg/L. The Khanewal as well as Vehari region had the lowest Mg values. In the Multan region, greater amounts of magnesium were found.

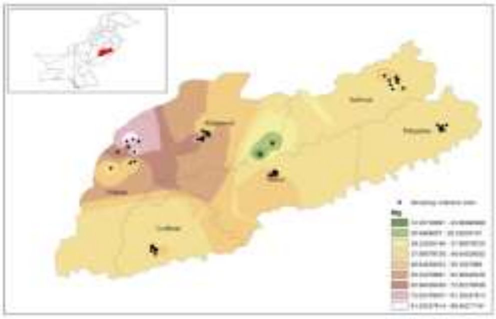

Figure 4.6: *Magnesium (Mg) groundwater concentrations distributed spatially (parts per million).*

4.7 Concentration of Na ions in Ground Water

The area of interest in and around Multan, which is about [10%] in size, is depicted on the sodium the adsorption percentage map as the Danger areas (Fig. 4.7). Other cities were discovered to be in a healthy area along Multan's half-area. whereas the area within the villages has adequate groundwater resources, this area is [90%] larger.

For the sodium danger region classification, the unsafe and safe areas are denoted by the colors pink and green, respectively. When compared to the 50 mg/L sodium (Na) safe level, the eastern half in Multan's drinking water was found to be unsafe (Fig. 8). On the other hand, the groundwater on Multan's western side met acceptable standards. 90% of people are within the safe zone, but 10% are in the sodium danger zone. The kidneys are harmed by sodium, a non-essential metal.

Spatial distribution about ground water's Na values is depicted in figure 4.7. The Na values range from 50 mg/L. The Sahiwal, Pakpattan, Lodhran, Khanewal, and Vehari regions showed the lowest Mg values. In the Multan region, higher levels of magnesium were found.

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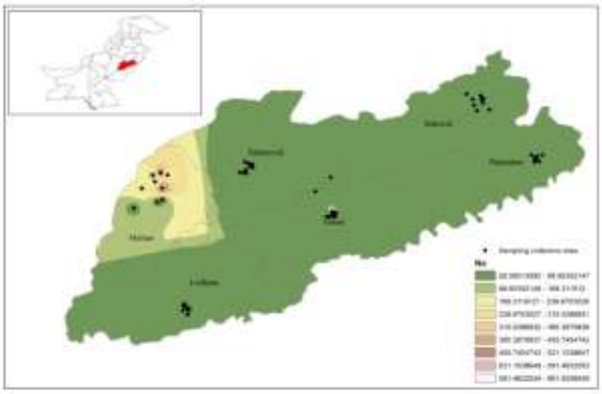

Figure 4.7: *Different sodium (Na) concentrations (parts per million) in groundwater are distributed spatially.*

4.8 Concentration of Hardness in ground water

The spatial distribution about ground water hardness values is depicted in figure 4.8. There are 250 possible hardness values. Pakpattan [180.05-225.36], Sahiwal, and Lodhran [225.36-270.67] location showed the lowest hardness values. In the region between 270.67 and 315.99, Multan, Khanewal, and Vehari, moderate hardness values were found. Higher hardness readings were found in the Vehari [497.24-542.56] and Multan regions.

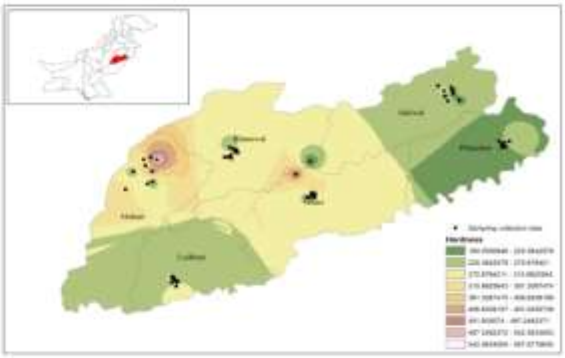

Figure 4.8: *Groundwater hardness (parts per million) spatial distribution.*

4.9 Concentration of K Ions in Ground Water

The spatial distribution about ground water's potassium values is depicted in figure 4.9. 10 mg/L is the range for potassium values. In the [1.96-5.18] region, which includes Khanewal, Sahiwal, and Vehari, the lowest potassium levels were found. Half of the Multan, Lodhran, as well as Vehari [13.25-14.87] region showed higher potassium values.

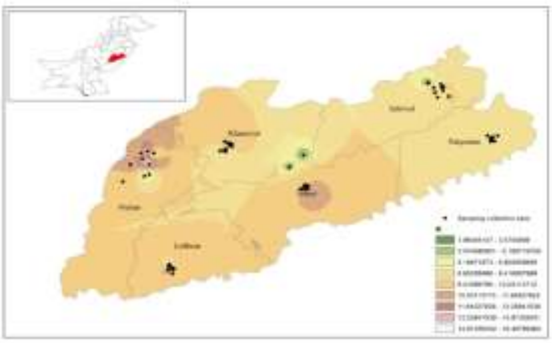

Figure 4.9: *Different potassium (K) concentrations (parts per million) are distributed spatially in groundwater.*

4.10 Concentration of Sulphate Ions in Ground Water

The spatial distribution about ground water's Sulphate values is depicted in figure 4.10. Sulphate values range from 250 mg/L. The regions of Multan, Sahiwal, and Khanewal [50.17-129.49] showed the lowest Sulphate values. Sulphate levels were found to be higher in the Multan [327.81-367.48] region.

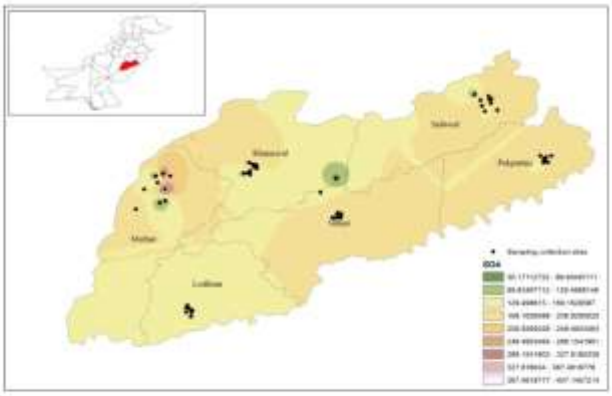

Figure 4.10: *Different sulphate quantities (parts per million) in groundwater are distributed spatially.*

4.11 Concentration of Nitrite Ions in Ground Water

The spatial distribution about ground water's nitrite values is depicted in figure 4.11. Nitrite values range from 0 to 5 mg/L. The regions of Multan, Pakpattan, Lodhran, Sahiwal, and Khanewal [0.126-2.04] showed the lowest Nitrite values. Higher Nitrite levels were found in the Multan [6.82-7.78] region. In the Vehari and Multan [2.04-4.91] region, moderate levels of nitrite were found.

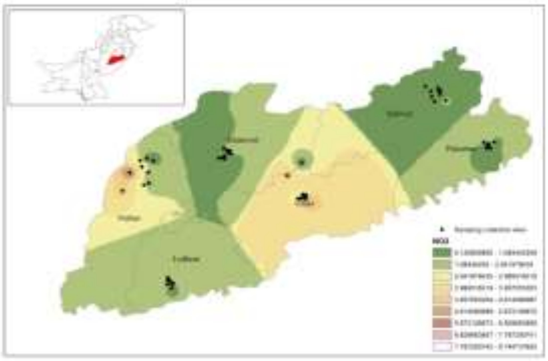

Figure 4.11: *Different Nitrite concentrations (parts per million) are distributed spatially in ground water.*

Table 1. The results of the physiochemical properties of Multan city's groundwater, which is used for drinking and other household purposes.

Sr.	City	Latitude	Longitude	pH	Turb.	Ca	Mg	Hard	Cl	Na	K	SO4	NO2 (N)	TDS	Cl2
1	Multan	30.081905	71.36766	7.6	0.25	85	38	330	58	58	8.9	200	4.3	425	0.1
2	Multan	31.128289	71.35102	7.95	1.22	79	92	280	49	56	4.75	79	0.53	371	0.7
3	Multan	31.1465	71.4406	9.14	1.77	42	19	300	172	220	2.8	252	1.3	700	0.2
4	Multan	30.187537	71.40817	7.57	1.25	94	72	220	180	260	11.2	154	7.3	438	0.3
5	Multan	30.116002	71.4857	8.5	0.3	40	39	280	98	58	5.9	78	2.7	525	0.2
6	Multan	30.126478	71.5116	6.9	0.25	110	52	200	110	46	4.5	110	0.52	380	12
7	Multan	30.189889	71.51078	8.02	0.52	100	89	450	382	670	16	410	1.29	350	0.2
8	Multan	30.223237	71.47414	7.85	0.24	66	66	380	145	140	15	149	4.5	582	0.2
9	Multan	30.270789	71.50177	7.3	0.54	49	88	490	466	580	16.6	367	0.31	390	1.9
10	Multan	30.258688	71.53714	7.82	0.23	99	79	590	98	130	6	194	0.11	562	0.3
11	Multan	30.258688	71.46498	7.25	0.45	49	89	240	39	81	8.1	49	2.1	369	0.1
12	Vehari	30.056267	72.38059	7.7	2.81	160	29	412	270	58	8.9	213	1.3	400	1
13	Vehari	30.036499	72.33583	7.46	1.02	60	51	200	240	35	2	80	0.7	345	0.1
14	Vehari	30.033663	72.34652	8.59	1	98	78	299	336	34	16	300	3.3	550	0.2
15	Vehari	30.035148	72.37652	7.5	0.3	40	50	230	200	49	12.6	251	7	800	0.1
16	Vehari	30.040449	72.35989	7.7	0.4	50	48	210	260	54	13	215	3	660	0.3
17	Vehari	30.04503	72.37899	8.62	1.5	39	51	230	200	28	11.3	150	9	645	0.3
18	Vehari	30.171283	72.27865	8.3	0.29	110	12	480	52	60	4	130	4.5	700	1
19	Vehari	30.246514	72.35481	7.5	0.34	48	19	180	38	38	3.9	80	0.5	510	0.1
20	Vehari	30.05833	72.36029	8.28	0.09	67	36	240	190	130	7	100	3.5	600	0.1
21	Vehari	30.062908	72.36533	7.9	0.4	72	47	560	300	200	11	250	1	700	0.2

22	Khanewal	30.329795	71.92523	7.2	0.3	83	35	200	90	53	9	250	0.5	500	0.1
22	Khanewal	30.273196	71.89919	8.5	1.09	75	90	250	110	56	6.5	90	0.34	680	0.4
23	Khanewal	30.266444	71.93153	8.5	1.73	44	45	400	200	67	3.8	110	1.3	900	0.3
24	Khanewal	30.274305	71.91803	7.3	1.32	49	80	210	180	50	10	150	1.23	438	0.2
25	Khanewal	30.29924	71.96529	8.2	0.3	49	93	240	99	59	6.9	87	0.9	450	0
26	Khanewal	30.317325	71.95477	6.9	0.34	110	52	180	105	46	5.4	98	0.34	479	0.8
27	Khanewal	30.321811	71.94185	9.5	0.42	119	49	260	200	39	12	180	1.9	700	0.1
28	Khanewal	30.31749	71.96236	7.85	0.25	70	38	389	150	140	11.5	194	2.6	680	0.1
29	Khanewal	30.306374	71.95202	7.8	0.45	58	52	200	466	60	12.5	376	0.31	400	1
30	Khanewal	30.286643	71.93177	8	0.23	95	58	500	90	47	8	149	0.45	5020	0.3
31	Sahiwal	30.6939447	73.0385	7.25	0.54	94	50	230	80	80	1.9	78	0.59	1300	0.2
32	Sahiwal	30.664557	73.06785	7.9	2.18	200	50	330	58	43	9.8	200	0.34	550	1
33	Sahiwal	30.685976	73.10828	8.05	1.2	70	49	250	200	39	5	189	0.3	345	0.2
34	Sahiwal	30.66944	73.12141	8.25	1.3	89	58	280	250	36	10	320	0.78	600	0.2
35	Sahiwal	30.66944	73.12058	7.5	0.3	50	50	234	58	49	13	215	1	940	0
36	Sahiwal	30.633824	73.07492	7.3	0.4	58	48	200	280	50	10	248	1.03	558	0.4
37	Sahiwal	30.610783	73.15092	10	1.52	93	53	210	200	51	9.5	189	1.4	645	0.3
38	Sahiwal	30.604253	73.08976	8.3	0.92	100	27	250	180	39	6	138	1.05	680	1
39	Sahiwal	30.646077	73.11938	7.9	0.29	52	19	180	38	56	4.5	90	0.5	520	0.2
40	Sahiwal	30.665547	73.1112	8.09	0.45	75	39	257	197	50	7.3	110	0.45	590	0.4
41	Pakpattan	30.367728	73.3624	7.5	0.2	98	49	200	250	49	9.2	251	1	700	0.1
42	Pakpattan	30.3599793	73.39203	7.9	0.4	200	50	240	89	38	8	185	4	400	1.2
43	Pakpattan	30.366715	73.41819	8.3	1	100	38	258	241	49	7	178	0.4	800	0.2
44	Pakpattan	30.333191	73.40058	8	0.2	70	49	230	253	48	11	300	0.78	670	0.3

45	Pakpattan	30.351551	73.37866	6.5	0.03	95	40	245	59	58	9	116	1	589	0
46	Pakpattan	30.332833	73.37812	9	0.5	68	38	180	268	48	4	148	1.3	590	0
47	Pakpattan	30.33826	73.38784	8.53	0.5	83	43	189	210	52	9	179	1	570	0
48	Pakpattan	30.349293	73.38269	9	0.8	152	38	210	185	38	3	182	1.2	700	0.3
49	Pakpattan	30.350129	73.38181	7.2	0.38	43	29	231	69	50	4.5	88	0.5	600	0.2
50	Pakpattan	30.330542	73.37812	8.9	0.28	65	49	257	97	49	7	120	0.1	553	1
61	Lodhran	29.51038	71.6382	7.7	0.56	54	39	400	280	27	8.2	100	0.2	600	0.6
62	Lodhran	29.532707	71.64172	7	0.5	50	58	215	245	45	4	89	0.4	642	0.9
63	Lodhran	29.541901	71.64603	6.3	0.3	79	68	288	345	39	12	210	0.5	500	0.8
64	Lodhran	29.545579	71.63531	7.2	0.2	78	42	278	200	59	12.6	222	5	820	0.7
65	Lodhran	29.531622	71.61485	7.9	0.24	54	38	210	459	47	16	167	1.08	600	0.5
66	Lodhran	29.556773	71.62534	7.3	1.3	29	29	200	200	28	14	156	3	450	0.4
67	Lodhran	29.557894	71.62395	8.23	0.11	100	35	187	59	62	3	138	0.4	678	1
68	Lodhran	29.560646	71.62346	7.98	0.32	58	28	180	39	38	5	90	0.5	510	0.7
69	Lodhran	29.568885	71.62102	8.45	0.03	57	56	230	178	134	7	160	0.4	600	0.6
70	Lodhran	29.555166	71.61615	10.5	0.6	62	58	450	250	48	8	230	1	750	0.6

There is a common misconception that for tap water to be considered pure, it must be tasteless, odorless, and colorless (Table 4.1). It must be clear and devoid of any suspended impurities or potentially dangerous microorganisms. Additionally, it must have the minerals and salts the human body needs as well as some dissolve gases that improve flavor. It is well known that some trace elements are crucial for maintaining human health. In water for drinking and their overconsumption could cause serious health issues (Adimalla et al., 2018).

To determine whether the water was fit for drinking, simple physical tests were run on the samples. Checks were made for turbidity, temperatures, odor, color, taste, color, and TDS. The average temperature of the water samples was roughly 250 degrees Celsius. Each sample had almost no foam, odor, color, or flavor, but turbidity and TDS varied widely from case to case (Ali el al., 2021).

The high turbidity of the liquid (0.5 NTU) of the research field may be spatially evaluated across the entire study area, as shown in Figure 4.2, which depicts the turbidity. The remainder of the sample locations, mostly in Multan's northeast and northwest, Khanewal, Lodhran, and Pakpattan, had turbidity levels below (0.5 NTU). The spatial distribution about ground water turbidity values is depicted in figure 4.1. The turbidity values range from 0.5 NTU. The areas with the highest turbidity readings were Vehari, Sahiwal, and central Multan. In the regions of Multan, Khanewal, Pakpattan, and Lodhran, lower turbidity values were found (Basharat et al., 2012).

According to the WHO's suitable turbidity level, water found in all of these places is suitable for drinking. Sahiwal and Vehari water is unfit to consumption by humans because it crosses WHO-permitted limitations, while the turbidity levels in the other locations are high (0.6 to 1.5 NTU). A high turbidity level can be caused by a number of factors, including an amount of unable to dissolve reduce iron, chalk particles, and inactive the clay in the groundwater(Qazi et al., 2014).

Conclusion

Most Pakistani cities' groundwater comes from mainly underground sources. The current study's three main objectives were to evaluate the drinking water quality in Multan, a heavily industrialized and populated area, analyze samples of water, and map utilizing the IDW technique. In order to evaluate the purity of tap water, qualitative as well as quantitative analysis that focused on the physicochemical characteristics of drinking samples was conducted. Both IDW techniques and various chemical evaluations were used to assess the water quality. This study's qualitative analysis method produced insightful information and data. All samples' measurements for color, flavor, and odor were acceptable. The levels of turbidity and hardness were acceptable. Additionally, the pH level fell within the permitted ranges according to WHO guidelines. Additionally, the TDS level fell between excellent and fair. To that end, samples via random waterways were gathered for the purpose to develop 3D raster maps according to eleven predefined parameters, and water quality was calculated using the IDW technique water quality index determined that more than 40% of the water samples examined were unfit for drinking. The results showed that Pakpattan's water supply was barely acceptable, but with the presence of an increase in reduce but sure and unchanged addition of contamination of contaminants from multiple unobserved human-caused incidents, the scenario is not very close to being understood harmful. The region of Pakpattan was not previously examined, thus these data will aid in assessing the problem and providing guidelines to develop preventative steps or solutions.

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