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Integrative Water Quality Index (WQI) Based Assessment of Ground Water Resources in Punjab, Pakistan

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Abstract

The needs of more than 70% of Punjab's residents for domestic use, agriculture and industry are met by groundwater. Today, its quality and sustainability have significantly deteriorated by fast urban growth, factory outflows, runoff from farms and unchecked water usage. The most prevalent human activity involving the subsurface of the Earth is groundwater extraction, 982 km^3 of groundwater were extracted annually worldwide. Water scarcity and a reduced supply of drinking water are the results of excessive groundwater pumping. Pakistan is among the nations that, by 2030, will have fewer renewable water resources than the estimated threshold value of 1500 m^3 per capita annually. A complete evaluation of groundwater quality was conducted in 36 districts of Punjab using 5,319 water samples collected from groundwater sources from both urban and rural areas. Empirical experiments involving Physical, Chemical and Bacteriological analysis were done in the laboratories. Key findings reveal alarming contamination levels, with 61.9 % of samples deemed unfit for drinking due to elevated concentrations of Total Dissolved Solids (TDS), heavy metals, and microbial pathogens. The WQI classification highlighted that over 10 districts in Punjab fall into the "unsuitable for drinking" category (WQI ≥ 300), posing significant public health risks, including cancer, fluorosis, and waterborne diseases. The results emphasize to develop integrated water management plans, strengthen law enforcement, inform the public and use modern resources of Geographical Information Systems for decision making and adopt lower cost water purification systems to improve the water quality of Punjab. Actions should include developing institutions, updating water quality guidelines, and encouraging rainwater collection as well as aquifer refilling. This research follows SDG 6.1, helping policymakers build policies that reduce groundwater risks and secure safe drinking water across Punjab.

Keywords: Groundwater quality analysis (GWQA), Water Quality Index (WQI), GIS mapping, Punjab, Sustainable Water Management.

1. Introduction:

Water is not only a vital resource for life, economic development, and environmental sustainability, but it also makes up more than 60% of the human body and plays a crucial role in supporting ecosystems, agriculture, and public health. However, this perception is now challenged by growing anthropogenic pressures. The overuse of fertilizers and pesticides, along with the disposal of untreated sewage and industrial waste, is eroding the natural filtration benefits of groundwater. Recent assessments across urban and rural areas of Punjab have reported elevated levels of Total Dissolved Solids, heavy metals, and coliform bacteria, underscoring a widespread threat to public health. Of particular concern is the widespread arsenic contamination in central and southern Punjab, which has been identified as a major carcinogenic hazard [1]. In Pakistan, over 70% of the population relies on

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groundwater, making it a cornerstone of the nation's domestic, agricultural, and industrial water supply systems [2]. Despite its importance, groundwater in Pakistan, especially in Punjab province is under increasing stress, both in terms of quantity and quality [3]. In highly urbanized districts such as Lahore, Faisalabad, and Multan, groundwater levels are depleting rapidly while contamination levels often exceed both National Drinking Water Quality Standards (NDWQS) and World Health Organization (WHO) guidelines [4, 5]. Given the scale and severity of these challenges, continuous monitoring, data-driven assessment, and geospatial analysis have become essential. Conventional water quality monitoring, while informative, lacks the ability to integrate large datasets and visualize contamination patterns effectively. Therefore, this study employs a combination of empirical data collection, laboratory-based physio-chemical and microbial testing results using APHA standards, to assess groundwater quality and identified the contamination hotspots across 36 districts of Punjab. More than 5,000 samples were analyzed, covering both urban cities and over 2,000 villages, to create a comprehensive spatial database and risk model. A calculation of Water Quality Indices (WQIs) used to consolidate and interpret assessment of groundwater conditions, facilitating informed decision-making by stakeholders. WQI have been established to represent the general water quality status. WQI combines various parameters in terms of concentration values and weightage as well as standard values. The primary advantage of WQI model is that it can evaluate frequent variations in water quality, and its index value shows potential water use directly. Water cannot be used until the model indicates the overall water quality. It involves limited number of parameters selected and needed to analyse for complete description of Water quality. Four steps need to be followed to develop a reliable WQI model: parameter selection, sub-index formation, weight establishment, and sub-index aggregation for the final value. The multiplicative approach is common in the aggregation method since low score values for any variable indicate poor environmental quality in the overall index. This study is timely and significant considering Pakistan's commitment to Sustainable Development Goal (SDG) 6.1, which calls for universal access to affordable and safe drinking water by the year 2030. However, progress remains slow, with only a 7% increase in safe water coverage between 2015 and 2020. The insights generated from this research will not only contribute to academic literature but also serve as an evidence-based guide for policy formulation, infrastructure development, and community-level water safety planning across Punjab[6]. Information regarding the ground water impurities was pertaining to public at large therefore it was necessary to educate/inform the future policy makers about this issue of Fit/Unfit drinking water. Main objective of this research was to conduct an extensive empirical assessment of Ground water quality across urban and rural districts of Punjab, Pakistan through systematic field sampling, Laboratory analysis and measuring its various physio-chemical and biological Parameters using standardized methods (APHA) ensuring data reliability and reproducibility.To develop and apply water quality indices (such as DWQI) based on measured data for quantitative classification and interpretation of ground water quality status as no extensive research work was found since last 10 years relevant to groundwater quality of Punjab, Pakistan. Empirically measured ground water quality data was integrated into Geographical Information System (GIS) for spatial mapping and visualization of contamination patterns across Punjab.

1.1. Groundwater Quality Status in Pakistan:

According to the Pakistan Council of Research in Water Resources (PCRWR), only 32% of the total population had access to safe and affordable drinking water as of 2021.According to WHO guidelines, "Safe water is the water which impose no health risk when lifetime used" [7]. The council has consistently monitored the water quality across all districts in Pakistan, revealing the alarming levels of contamination across multiple parameters. The PCRWR's year-wise summary (2002–2020), has shown over 77% of the samples declared un-fit for drinking based on chemical, microbial, and physical contamination standards [8]. In rural areas, particularly in the arid and semi-arid regions of South Punjab, groundwater quality assessments have indicated varying degrees of suitability for drinking and irrigation purposes[6]. A study conducted in Bahawalpur district analyzed 120 groundwater samples and found that a significant proportion had high levels of TDS, nitrates, and heavy metals, rendering them unsuitable for consumption in 2016 [9]. The below graph (Fig.1) depicts the ground water quality status of Pakistan as reported by PCRWR in Pakistan.

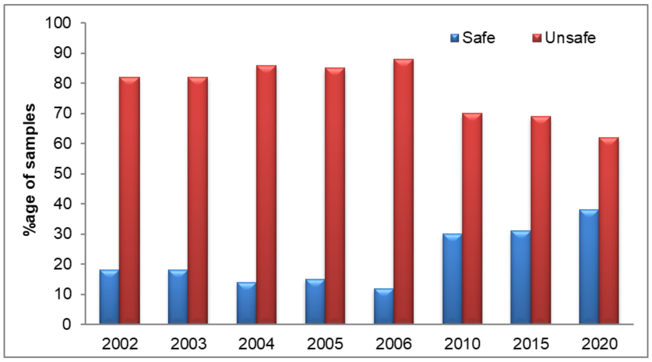

Figure 1: Year wise Ground Water Quality Status of Pakistan [2]

In the industrial areas of Peshawar, groundwater samples showed high concentrations of potentially harmful elements such as lead (Pb), cadmium (Cd), and chromium (Cr)[10]. The primary sources of these contaminants were identified as industrial discharges and improper waste disposal practices[11]. This involves developing water quality assessment methods, policies, and technologies to manage and conserve groundwater, reduce water loss, and improve quality based on a decade of nationwide studies identifying key contaminants. Also reports have shown that Faisalabad in 2017 have experienced severe groundwater contamination due to industrial effluents and domestic waste[12]. A study in Faisalabad revealed elevated levels of total dissolved solids (TDS), electrical conductivity (EC), and heavy metals in groundwater samples, exceeded World Health Organization (WHO) standards [13]. Another geogenic pollutant that poses a great danger to groundwater is Fluoride. Although fluoride is essential at a low level in order to protect the teeth but its high concentrations cause dental and skeletal fluorosis which has great impact on the quality of people's lives [14]. Between 2012 and 2025, many studies were published that emphasized the negative impacts of contaminants in groundwater. Recent research conducted in District: Sargodha, Pakistan in 2025 computed WQI Score around 84 "Classifying as Poor for Drinking purpose without Treatment although suitable for irrigation"[15]. Another study conducted in 2024 for different industrial regions of Punjab, Pakistan (Multan, Gujranwala, Faisalabad and Lahore) revealed that carcinogenic risk values were high in comparison to the permissible limits in all districts indicating significant cancer risk for Childrens [16]. Multiple studies have found that in both rural and urban areas of Pakistan, bacterial contamination has become major health concern and it causes multiple infectious diseases. In 2011, a systematic review was conducted in four Pakistani provinces. According to the study, 64% of samples from Punjab Province, 67% of samples from Khyber Pakhtunkhwa Province, 83% of samples from Sindh Province, and 80% of samples from Baluchistan contained coliform bacteria [17]. Primary sources of water pollution involve leakage of pipes used in water distribution network, excess use of fertilizer and pesticides in agriculture, sewage discharge in nearby fresh water sources and industrial wastewater discharge without any proper treatment. All these activities release harmful and toxic substances which act as a pollutant for groundwater. Solid waste generation in Pakistan is around 49 million tons per year which is mostly disposed off openly or in form of Landfills with adverse effects on groundwater [18]. Although WQI-GIS studies already exist for Punjab, but they have few limitations as they rely only on basic few water quality parameters and seasonal variations were also not considered which further lead to distorted WQI results. However, in this research work samples collected from groundwater resources along with their GPS coordinates to identify pollution hotspots and were analyzed in Laboratory for at least 15 water quality parameters including heavy metal (Arsenic) and Pathogens as well. Punjab, Pakistan's water studies provided deeper insights, identify contamination hotspots, support better public health policy (reducing waterborne diseases), aid in sustainable management, and make complex data accessible for targeted interventions and allocations of resources by incorporating scientific value (such as advanced WQI models, GIS mapping, and multivariate analysis).

1.2. Current Trends in Groundwater Table Decline:

Beyond contamination, the rapid depletion of the groundwater table is another critical concern. In Punjab, the water table is reported to be declining by up to 3 feet per year, with some areas now requiring boring depths of 800 feet or more[11]. This is largely due to excessive pumping for agriculture, which in turn is a response to water scarcity in surface supplies. Additionally, the lack of water storage infrastructure Pakistan has only 3 major dams compared to 22,000 in India further exacerbates overreliance on groundwater[19]. The decline in water tables is not only a supply issue but also increases the risk of contamination from deep-earth minerals, intensifying the need for quality monitoring[3]. The overuse of groundwater resources for irrigation, along with ineffective groundwater sector management and control, are the causes of this loss[13, 20].

1.3. National Drinking Water Policy and Regulatory Framework:

Recognizing the critical state of drinking water quality, the Government of Pakistan approved the National Drinking Water Policy (NDWP) in September 2009. The policy aims to provide safe, accessible, and affordable drinking water to the entire population by 2025. It emphasizes the establishment of water quality standards, regular monitoring, and the development of infrastructure to ensure the sustainability of water supply systems. Groundwater quality models also play a significant role in simulating the distribution and occurrence of pollutants in aquifers, making decisions and planning on contamination threats, methods of control appraisal and for achieving remedial measures. The goal of these models is to provide decision makers with a quantitative and/or qualitative analysis of regionally based risk of contaminate invasion for which they base their decision on few point-based measurements and the ability to estimate the future quality of groundwater under given conditions [21].

2. Methodology:

2.1. Study Area Description:

This study was conducted in the Punjab Province of Pakistan, Bordered by Khyber Pakhtunkhwa, Azad Kashmir, Indian Punjab, Sindh, and Baluchistan. Punjab is traversed by the major rivers of the Indus basin: Chenab, Jhelum, Indus, Ravi, and Sutlej. The province includes diverse terrains from the Cholistan desert in the southeast to the Potohar plateau in the north with agricultural plains dominating the landscape [22].

The sampling framework was based on a comprehensive survey of 36 districts of Punjab. About 5319 groundwater samples were collected across urban and rural areas using random sampling techniques. The spatial distribution of sampling points ensured coverage of all physiographic zones.

2.2. Sample Collection Procedure:

Groundwater samples were collected from sources such as tube wells, hand pumps, and motor pumps, primarily from depths of at least 100 feet to ensure representative aquifer samples. All samplings were carried out following standard APHA protocols and Sterilized bottles were used for sample collection. Appropriate preservatives were added where necessary. Samples were stored at 4°C and transported to District Water Testing Laboratories of Public Health Engineering Department. GPS coordinates (latitude and longitude) were recorded for each sampling location and standardized Water Quality Performa (Excel-based datasheet) was circulated among PHED laboratories to record experimental water quality Analysis.

The collected samples were analyzed and tested in accordance with the American Public Health Association (APHA, 2017) Standard Methods for physical, chemical, and microbial analysis.

Table 1 lists the parameters and methods used:

Table 1: Analytical Parameters and Methods [23]

Sr. No	Parameter	Method (APHA)
1	pH	Electrometric (4500-H^+-B)
2	Temperature	Mercury Thermometer
3	Electrical Conductivity	Conductometric (2510-B)
4	Turbidity	Nephelometric (2130-B)
5	TDS	Drying Method (2540-C)
6	Fluoride	SPANDS Method (4500-F D)
7	Calcium	EDTA Titration (2500-Ca B)
8	Magnesium	EDTA Titration (2340-C)
9	Total Alkalinity	Titration (2320-B)
10	Chlorides	Argentometric (4500-Cl B)
11	Sulphates	Turbidimetric (4500-SO_4-E)
12	Nitrates	Spectrophotometry
13	Nitrites	Colorimetric (4500-NO_2 B)
14	Total Hardness	EDTA Titration (2340-C)
15	Arsenic	AAS & Field Kit
16	Potassium, Sodium	Flame Photometry
17	Total Coliforms	Membrane Filtration (9221 B–D)
18	Iron	Phenanthroline (3500 Fe-B)

Each parameter was tested using calibrated instruments like pH meters, Palintest photometers, turbidity meters, flame photometers, and atomic absorption spectrophotometers as applicable.

2.3. Water Quality Index (WQI) Calculation:

To quantify the groundwater quality, the Drinking Water Quality Index (DWQI) was employed using the Weighted Arithmetic Method [24], which involves the following equations (1),(2) & (3):

$$DWQI = \sum_{i=1}^{n} QiWi \quad \text{........Eq. (1)}$$

$$\mathrm{Qi} = \frac{\mathrm{Ci}}{\mathrm{Si}} \times 10 \quad \text{.... .... Eq. (2)}$$

$$\mathrm{Wi} = \frac{\mathrm{wi}}{\Sigma \mathrm{wi}} \quad \text{...... Eq. (3)}$$

Where:

- Q_i = Index of sub-quality for every parameter
- C_i = Ground Water Concentration
- S_i = Standard for Drinking water parameter (WHO)
- $W_i = K/S_i$
- K = Ratio of a constant/Proportionality constant
- K value helps determine unit weights ($W_i = K/S_i$) for each pollutant, resulting in a comprehensive WQI score. It is calculated as ($K = 1/\Sigma(S_i)$, where S_i is the standard permissible value for each parameter. This normalizes the influence of various parameters, ensuring their combined impact reflects overall water quality.

Delphi technique was used for selection of water quality parameters for WQI calculations. These involved pH, Turbidity, TDS, T. Hardness, Chlorides, Nitrate, Fluoride, Arsenic and T. Coliform.

Based on calculated WQI values, water quality was categorized into[25]:

- "Excellent: WQI < 50"
- "Good: 50 ≤ WQI < 100"
- "Poor: 100 ≤ WQI < 200"
- "Very Poor: 200 ≤ WQI < 300"
- "Unsuitable for Drinking: WQI ≥ 300"

The benefit of this model is that it can evaluate frequent variations in water quality, and its index value indicates potential water use.

2.4. GIS Mapping:

Digitization of data and office automation is the key to success in all over world. Data must be formulated and translated in information and that to be used in efficient and better decision making at higher level. Computer based Software are utilized for office automation and taking advantage of digitization in maintaining large amount of data for processing. One of the best ways to present data having geographic content is through some *Geographic Information System (GIS)* with relevant attributes [24, 26].Spatial data integration was done by taking input of water sample locations along with coordinates and their relevant quality parameter values into ArcGIS software. These water quality maps were than combined with geology to assess areas prone to pollution.It was found that the kriging method worked well for managing and interpolating groundwater parameters for continuous surface maps using ArcGIS.GIS Map prepared by using Software Arc GIS and converting each Fit/Unfit impurity in relevant standard colors and symbols for easy understanding along with their relevant information regarding the ground water impurities was pertaining to public at large therefore it was necessary to educate/inform the future policy makers about this issue of Fit/Unfit drinking water.

3. Results and Discussion:

3.1. Overview of Water Quality Analysis:

A total of 5,319 groundwater samples were collected and analyzed from 36 districts of Punjab, covering both rural and urban areas. The data revealed that 2028 samples (38.1%) were found fit for drinking purposes, while 3291 samples (61.9%) were unfit as per WHO and NDWQS standards. The distribution of unfit samples was as follows: Physically Unfit were 1,739 samples and Chemically Unfit were 2,414 samples whereas Bacterially Unfit were 804 samples as shown in Fig. 2.

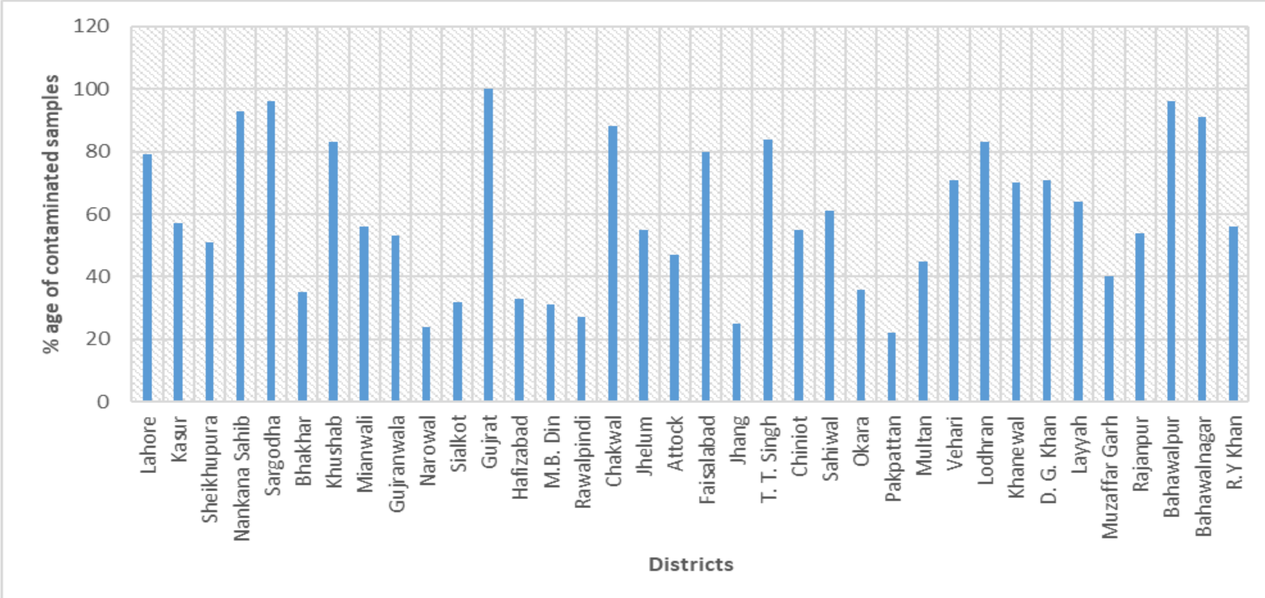

Figure 2: Percentage of contaminated samples in Punjab, Pakistan

The graph depicts that maximum contaminated samples were observed in district: Gujrat and situation was better in district: Okara with minimum contaminations in province: Punjab, Pakistan. These findings underscore the widespread contaminations such as Total Coliform, Sulphates, Chlorides, Nitrates, High TDS in groundwater quality across Punjab and highlight the urgent need for systematic monitoring, policy enforcement, and remediation efforts[13].

3.2. Major Contaminants and Spatial Trends:

The groundwater samples were evaluated against a broad spectrum of parameters including pH, TDS, turbidity, total hardness, chlorides, nitrates, fluoride, arsenic, and total coliforms. Significant spatial variability in contamination was observed:

- High TDS (>1000 mg/L) was a prevalent issue across Faisalabad, Bahawalpur, Lahore, and Kasur. Main cause of rise in TDS level observed were pesticides from agricultural runoff, various chemicals from Urban waste and excess of minerals in the soil.
- Microbial contamination (T. Coliform) was most frequent in Gujrat, Rawalpindi, and Mandi Bahauddin. Poor water and sanitation services were observed in these areas as the main cause of pathogens and water borne diseases such as cholera, malaria, and typhoid [27]. As mentioned earlier in 2011, 64% samples from Punjab province were bacterially contaminated and recent experimental work conducted in this research revealed that 62% samples were overall unfit for drinking purpose (for samples collected in 2022 and 2023).
- Fluoride contamination exceeded safe limits in Khanewal, Bahawalnagar, and Layyah. Naturally excess in fluoride can be from rocks and soil, however few human related activities such as use of phosphate fertilizers and other Coal burning activities may also cause its contamination in groundwater[27].
- Arsenic presence, a known carcinogen[28], was notably high in Sheikhupura, Lahore, and Multan. Improper disposal of industrial waste were the main cause of arsenic contamination[19].

Table 2: District wise Groundwater quality analysis-Summary sheet

Sr. No.	District	Physical Status (Fit)	Physical Status (Unfit)	Chemical Status (Fit)	Chemical Status (Unfit)	Bacterial Status (Fit)	Bacterial Status (Unfit)	Overall Status (Fit)	Overall Status (Unfit)
1	Lahore	105	1	60	46	34	72	22	81
2	Kasur	71	65	66	124	12	59	17	119
3	Sheikhupura	96	3	63	36	59	40	62	37

4	Nankana Sahib	84	18	84	18	79	23	65	37
5	Sargodha	33	17	46	4	46	4	41	8
6	Bhakkar	63	14	59	18	59	18	50	27
7	Khushab	84	3	64	23	46	41	46	41
8	Mianwali	59	16	35	40	63	12	33	42
9	Gujranwala	91	5	40	56	17	79	17	79
10	Narowal	50	8	46	12	44	14	43	15
11	Sialkot	25	6	25	6	24	7	24	7
12	Gujrat	90	0	79	11	0	90	90	0
13	Hafizabad	38	19	38	19	38	19	38	19
14	M.B. Din	59	0	48	11	14	45	18	41
15	Rawalpindi	27	0	27	0	27	0	27	0
16	Chakwal	23	27	10	40	24	26	24	26
17	Jhelum	41	3	36	8	35	9	24	20
18	Attock	33	4	26	11	15	22	15	22
	Total North	958	223	689	492	620	509	459	719
19	Faisalabad	184	559	177	566	644	99	592	151
20	Jhang	201	0	151	50	0	201	151	50
21	T.T. Singh	77	57	25	109	17	117	22	112
22	Chiniot	59	5	32	27	18	46	17	47
23	Sahiwal	59	37	25	71	25	71	30	66
24	Okara	183	84	174	93	26	231	16	241
25	Pakpattan	89	23	46	66	31	81	34	78
26	Multan	92	54	215	157	94	173	85	182
27	Vehari	96	144	71	169	48	192	70	170
28	Lodhran	74	146	95	125	30	190	45	175
29	Khanewal	171	143	128	186	56	258	95	219
30	D.G. Khan	92	218	145	165	45	265	91	219
31	Layyah	149	57	147	59	53	153	62	144
32	Muzaffar Garh	223	41	143	121	199	65	135	129
33	Rajanpur	195	130	145	180	65	260	72	253
34	Bahawalpur	188	133	186	135	88	235	90	233
35	Bahawalnagar	139	140	84	195	124	155	90	189
36	Rahim Yar Khan	38	48	38	48	45	41	38	51
	Total South	2402	1739	1727	2414	1339	2802	1569	2572
	Grand Total	3360	1962	2416	2906	4009	1313	2028	3291

3.3. Water Quality Index (WQI) Evaluation:

The Drinking Water Quality Index (DWQI) calculation results showed a concerning number of districts falling under the "unsuitable for drinking" category. The table 3 below highlights the classification:

Table 3: Classification of districts with respect to WQI

WQI Range	Water Quality	Districts
< 50	Excellent	Lahore, Mandi bahu Din, Gujrat, Jhelum, Pakpattan
50 – 100	Good	Gujranwala, T.T.Singh, Jhang, Mianwali, Okara, Attock, R.Y.Khan, Sialkot, Narowal
100 – 200	Poor	Rawalpindi, Khanewal, D.G.Khan, Khushab, Layyah, Sahiwal
200 – 300	Very Poor	Vehari
> 300	Unsuitable for Drinking	Faisalabad, Chiniot, Lodhran, Nankana Sahib, Bahawalpur, Kasur, Hafizabad, Bhakkar, Sargodha, Bahawalnagar, Multan, Sheikhupura, Rajanpur, Muzaffargarh, Chakwal.

These results demonstrate that while a few districts maintain good groundwater quality, the majority fall into poor to unsuitable categories, posing serious public health risks.

3.4. GIS Mapping of Ground Water Quality Parameters:

GIS Mapping of Water Quality prepared for 36 Districts of Punjab was reviewed for data verification, processed, and projected in GIS with associated benefits. Ground Water Quality Analysis (GWQA) through sampling, 5,300 water samples was reported for testing impurities for drinking purpose. This GIS map (Fig. 3) is for Punjab province indicating green points for water samples fit for drinking purpose and black points for water samples unfit for drinking purpose. These quality maps were helpful in overall assessment and identification of pollution hotspot for better water management. It represents water quality variation across Punjab, Province for its suitability either for drinking purpose or irrigation.

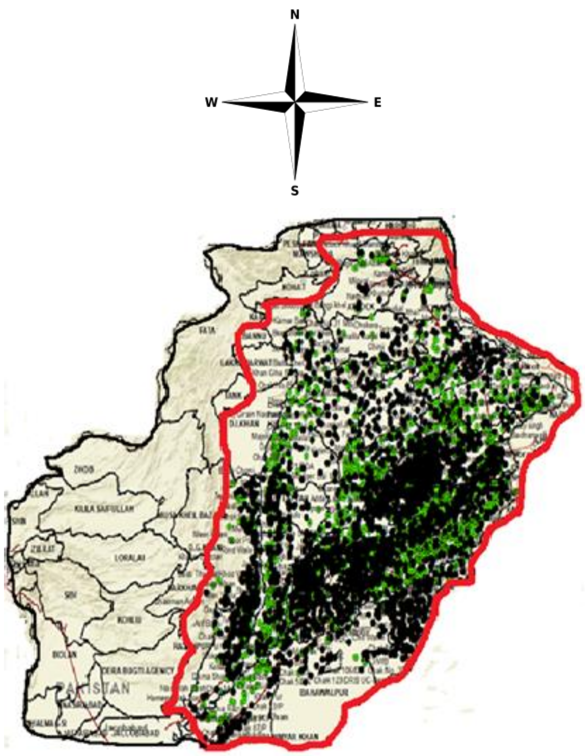

Figure 3: GIS Map for groundwater Quality Status of Punjab

3.5. Health Implications and Contamination Sources:

The deterioration in water quality correlates directly with adverse health outcomes as reported in table 4.

Table 4: Health implication by contaminations [9]

Contaminant	Health Risks
Arsenic	Skin lesions, cancer, cardiovascular issues
Nitrates	Blue baby syndrome in infants
Fluoride	Dental and skeletal fluorosis
Coliforms	Diarrhea, cholera, hepatitis, typhoid
Sulphates/Chlorides	Gastrointestinal irritation

Major contamination sources include industrial discharge, agricultural runoff, leakage from sewage systems, and poorly maintained water infrastructure. In Pakistan 40 % deaths and 50 % water borne diseases are just because of contaminated drinking water[17].

3.6. Discussion and Interpretation:

The study results underscore the critical state of groundwater quality in Punjab. Despite some improvements due to increased awareness and localized interventions, the overall picture remains concerning. The following insights emerge:

- The WQI approach provided a clear, actionable representation of ground water quality. Only 5 Districts of Punjab have Excellent water quality for drinking purpose whereas 15 districts have groundwater quality completely unsuitable for domestic use.
- Many contamination issues arise from preventable sources, highlighting the need for stricter regulation and community-level awareness programs.
- The diversity in groundwater quality across districts calls for district-specific policy frameworks and localized treatment strategies[27].

4. Conclusion:

In this research, ground water quality data collected, analyzed, and reviewed have offered a complete picture of existing water quality monitoring and assessment in Punjab, Pakistan. Punjab's groundwater resources are under serious threat due to various contaminations such as High TDS, Sulphates, Chlorides, Arsenic, Total Coliform, Fluoride, Total Hardness, Turbidity, salinity, and excessive extraction. Major contaminations causing deterioration of ground water quality involves agricultural runoff, improper sewerage disposal, climate change and natural disasters[3]. A multifaceted strategy including technological innovation, community involvement, regulatory enforcement, and agricultural practices will be necessary for the active management of groundwater resources. Two similar elements significant to the water resources are: The institutional frameworks that are present and shape of the governance practices. Integrated water resource management (IWRM) is an internationally acknowledged concept that seeks to ensure all water, land, and related resources is used efficiently for the benefit of socio-political welfare without the depletion of resources to establish and maintain a strong water quality monitoring system in Province Punjab, this document describes the current state of ground water quality. This studies implementation will give stakeholders a methodical way to guarantee that its residents have access to safe and clean drinking water and to manage water resources in a sustainable manner.

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Conflict of Interest:

The authors declare no competing financial or non-financial interests in relation to this work.

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