Determination of Water Quality using Water Quality Index of Jamrao Canal near Jhudo, Sindh Pakistan

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Abstract: The current study set out to describe the drinking water quality of Jamrao Canal Jhudo. The densely populated Pakistan city of Sindh utilizes a lot of water while simultaneously dumping mixed solid waste and untreated sewage into the Jamrao Canal, directly harming the water quality. The Pir Bodla farm in the village, Jhudo, and a few other areas in Sindh's Mirpurkhas district are all irrigated by this canal. We collected samples from the Jamrao canal's three distinct locations by the interval of 15 days and taken the three attempt using a multistage random sampling technique. Conventional methods were used to describe the water quality. The results were contrasted with the suggested upper limits for acceptable readings provided by the World Health Organization (WHO).

While dissolved oxygen (DO), pH, and nitrate samples all remained below the WHO standard limits, total dissolved solids (TDS), electrical conductivity (EC), chloride (34%), turbidity (40%), and hardness (11%) samples did not. To stop diseases linked to drinking water from spreading, it is vital to strengthen water quality management measures. As a result, drinking the water from these locations is dangerous.

Keywords: WQI; water quality; physicochemical parameters; Jamrao Canal water

1. Introduction

Drinking water quality is declining as a result of anthropogenic and natural activities that introduce pollutants into freshwater bodies of water and the water delivery system. While anthropogenic contamination primarily results from the use of pesticides and herbicides in agriculture, the leaching of poisonous toxins from septic tanks, waste disposal, coal mining and petroleum refining, etc., natural geodesic contamination of water is governed by the presence and concentration of various chemical constituents, which are primarily derived from the geological formation of the particular region [4,6].

Families suffer from inadequate access to safe water in a variety of ways, including when small children pass away from infections that could have been prevented. Reduced cognitive function and academic success are further grave outcomes [3-5]. Due to a history of poor health as children and the weight of recurrent illnesses in adulthood, these youngsters have worse prospects for success [3-5].

Only 20% of Pakistan's population had access to clean water, according to a household study [6]. Poor sewage systems, industrial waste, pesticides, and fertilizers are the main causes of water contamination [6, 7]. In Pakistan, there is a considerable risk of spreading water-related pollutants to the community due to outdated sewage infrastructure and local governments' failure to keep sewage lines away from drinking water supplies [8]. When there is minimal pressure or when the water supply is totally shut off, contaminants can enter the water distribution system [9]. Additionally, because they frequently lack on-site water storage, community center’s like Homes, businesses, and office building sites must rely on alternative water sources including springs, rainwater that has been collected, and private water suppliers. The majority of local water providers are unregistered, and there is no water quality control. The drinking water is susceptible to cross- and secondary contamination as a result of unsanitary handling [10–12].

Unsafe for human consumption, unprotected springs and wells frequently supply water [8].

Inadequate sewage treatment and sanitation increase the risk of fecal-oral disease transmission and contaminate the water supply [12]. Between urban and rural areas, Pakistan's population is significantly underserved in terms of improved sanitation infrastructure [6, 7]. Overall, poor sanitation has a significant negative impact; according to a recent study, the unimproved water and sanitation service cost Pakistan's economy almost USD 5.7 billion, or nearly 4% of its GDP [8].

The most populous city in Pakistan's Sindh province is Jhudo. The purpose of this study is to comprehensively evaluate the drinking water quality in the Jamrao canal in Sindh Providence, Pakistan. The majority of villages use the water from the Jamrao for household and drinking purposes. We focused on Sindh province as prior studies have indicated poor water quality in community water sources, and inferior canal performance as compared to the rest of the country [6,13].

The WQI has been extensively used to assess the appropriateness of groundwater and surface water for irrigation and drinking [10,14-17]. Depending on the intended usage, many approaches are employed to calculate a WQI [15,18,19]. To properly portray the WQI data, some studies have used geographical information system (GIS) techniques [18,20,21].

2. Materials and Methods

2.1. Study Setting and Sampling

90% of the people of the city and the neighboring villages depend on the water from the Jamrao Canal, which is located in the southwest of the Pakistani province of Sindh. The Sindh province is split into the South, North, and Central climatic areas. It is further divided into 29 districts [13]. The province is located in a subtropical area. Winter weather is still chilly (9 to 30 °C). In contrast, summer days are typically dry and hot with cold nights. North Sindh experiences higher summertime temperatures, averaging 45 to 50 C. South Sindh, on the other hand, experiences cooler temperatures of 35 to 38 C. In the north, surface and groundwater are the main sources of drinking water, whereas the Sindh Canal is the main supply in the middle Sindh region (Figure 1). The villages of Mirpurkhas and Jhudo are located in Sindh, which is close to the Arabian Sea. The groundwater in these villages is extremely salty and cannot be drank without treatment [22–24]. As a result, the primary supply of drinking water in the aforementioned districts is canal water [25–27]. (Figure 1).

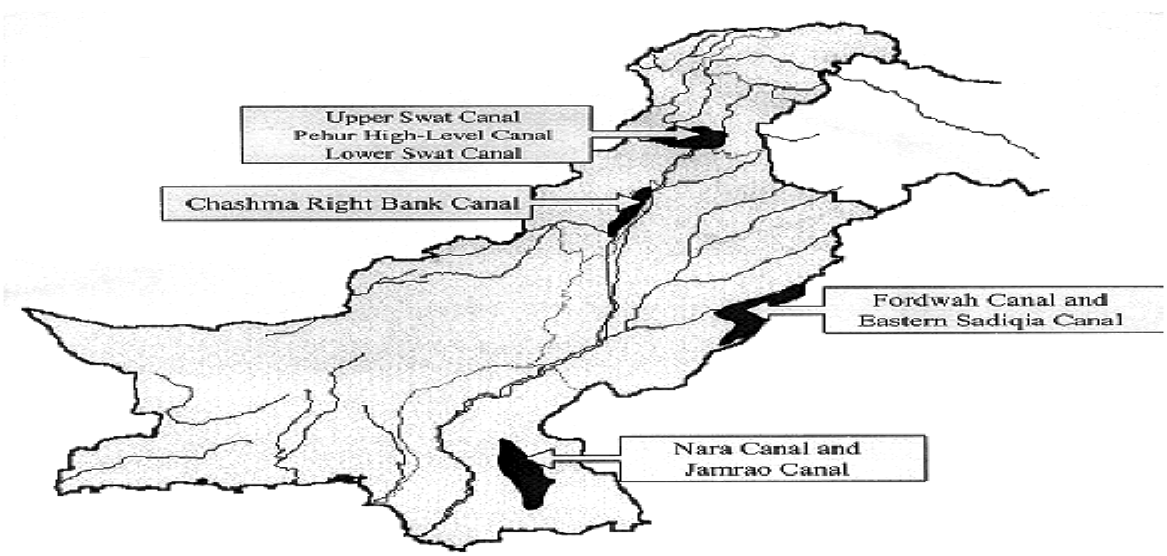

Figure 1. Surveyed Locations of Jamrao Canal in the Sindh province of Pakistan.

2.2. Water Sample Collection

In each area, water samples were taken from drinking sources. Nine physicochemical factors in all were used to evaluate water quality. A multi meter was used to assess the DO, pH, EC, TDS, and turbidity parameters on-site (Table 1) [28,29]. 1000 mL of drinking water was collected in sterile polythene bottles and sent to the lab in a carrier at standard temperature for the parameters that were examined in the lab.

Table 1. instruments for laboratory analysis and measurement**.**

Parameter	Instrument	Model/Method
DO	DO meter	BQT67-DO
pH	pH Meter	BAQS1234
EC/TDS	EC/TDS Meter	BSA1255-TDS
Turbidity	Turbidity Meter	HGSAWO43-T
Chloride	Titration Method	3300-Cl
Total Hardness	Titration Method	3001 H
Nitrate	Spectrophotometer	656-NO3
Phosphate	Spectrophotometer	4500-P

2.3. Water Sample Analysis

For chloride and overall hardness, a titration-based standard approach was utilized [17,30]. A common method based on a UV-visible spectrophotometer was used to measure phosphate and nitrate [31].

2.4. Water Quality Index (WQI) Calculations

The significance of certain characteristics depends on how water will be used. The WQI was assessed taking into account the following significant factors: (1) the parameter's significance; (2) the statistical link between the parameter's concentration and the corresponding index; (3) the connected water quality parameters; and (4) the classification of water quality (excellent, good, poor, very poor, water unsuitable for drinking). The adequacy of the water quality indicators for human consumption is examined in this study. The World Health Organization's (WHO) recommendations for drinking water quality were utilized as the "standards" (standard values of several parameters) for the drinking water used in this study [22,23]. Using previously employed techniques, a WQI was determined [16,18,19]. The WQI computations are broken down into three separate phases. As shown in Table 2, each parameter was first given a weight (wi) based on its proportional value in the overall quality of drinking water. This weight was determined by previous studies [16,18]. The weights were converted to relative weights, and the following equation was used to make them sum up to one:

$$Wi = wi/\sum_{i=1}^{n} wi \quad (1)$$

A "quality rating" (qi) was calculated as:

$$qi = (Ci/Si) \times 100 \quad (2)$$

where Ci is the concentration of parameter i and Si is the WHO standard value for parameter i [23]. A sub-index is calculated as the product of the quality rating and the relative weight:

$$SIi = wi \times qi \quad (3)$$

These sub-indices' combined values represent the overall WQI [15,16,18]. A classification is given based on the WQI's value (Table 3).

Table 2. Raw and relative weights for each water quality parameters [14,18,20,32].

Parameter	WHO Standard [23]	Weight (wi)	Relative Weights (Wi)
DO mg/L	5	5	0.16
TDS (mg/L)	1000	5	0.16
EC (uS/cm)	1500	4	0.12
pH	6.5–8.5	4	0.12
Turbidity (NTU)	5	2	0.06
Chloride (mg/L)	250	3	0.09
Hardness (mg/L)	500	2	0.06
Phosphate (mg/L)	5	1	0.03
Nitrate (mg/L)	50	5	0.16
		Σ wi = 31	Σ Wi = 1.00

wi: Weight assigned; Wi: Relative weight; Σ Wi = sum of all relative weights; * = (WHO) guidelines available.

Table 3. Characterization of water quality based on water quality index (WQI) value [33,34].

Class	WQI Value	Water Quality Status
A	<50	Excellent
B	51–100	Good
C	101–200	Poor water
D	201–300	Very Poor Water
E	>300	Water unsuitable for drinking

3. Discussion and Results

3.1. Characteristics of Drinking Water

Drinking water samples were taken from the point of use at these three different places, and around one-third of Canal reported that the water is available year-round from the main source. At 6% of the Canal, there were on-site water treatment systems available. But for the previous two years, none of these Canal had examined the quality of the drinking Water.

As indicated in Tables 4-6, the average concentrations for each Canal's zones for the drinking water quality parameters (DO, TDS, EC, pH, Turbidity, Chloride, Hardness, Phosphate, and Nitrate) were calculated. These three areas had the worst water quality overall. The average TDS, turbidity, and chloride concentrations were higher than the WHO's recommended levels in Jhudo, Jamrao Canal, and Pir Bodla Farm [22,23].

Table 4. First Attempt of Water quality parameters (Jamrao Canal, Jhudo and Pir Bodla Farm).

Locations	**Jamrao Canal**			**Jhudo**			**Pir Bodla Farm**		
	***n*= 5**			***n*= 6**			***n*= 8**		
Statistics	Average	Max	Min	Average	Max	Min	Average	Max	Min
DO mg/L	7.1	8.0	6.0	7.3	8.0	6.2	7.0	8.0	6.4
TDS (mg/L)	1083.1	2002.0	1356.0	1080.7	2024.0	1380.0	1068.0	2320.0	1260.0
EC (uS/cm)	2098.5	6600.0	250.0	2292.1	7190.0	760.0	1805.6	4550.0	510.0
PH	7.8	8.4	6.9	7.6	8.3	6.8	7.9	8.7	7.2
Turbidity (NTU)	25	30	27	23.5	29	26	24	22	20
Chloride (mg/L)	350.9	480.0	410.0	349.5	477.2	412.5	351.2	488.3	413.5
Hardness (mg/L)	199.9	250.0	201.0	210.9	254.0	202.0	201.3	254.0	189.0
Phosphate (mg/L)	0.5	2.1	0.0	0.8	2.0	0.0	0.7	1.2	0.0
Nitrate (mg/L)	5.7	27.0	0.0	1.3	20.9	0.0	7.0	20.7	0.0

Table 5. Second attempt after 15 days Water quality parameters (Jamrao Canal, Jhudo and Pir bodla form).

Locations.	**Jamrao Canal**			**Jhudo**			**Pir Bodla farm**		
	***n*= 5**			***n*= 6**			***n*= 8**		
Statistics	Average	Max	Min	Average	Max	Min	Average	Max	Min
DO mg/L	7.2	8.1	6.3	7.3	8.0	6.3	7.5	8.2	6.8
TDS (mg/L)	1089.2	1900.0	1590.0	1079.2	1890.0	1588.0	1095.7	1888.0	1570.0
EC (uS/cm)	1395.7	4860.0	480.0	1628.2	3670.0	360.0	1818.2	4830.0	250.0
PH	7.5	8.2	7.0	7.5	8.3	7.0	7.8	8.4	7.1

Turbidity (NTU)	26	31	28	24	30	23	25.5	30.5	22.7
Chloride (mg/L)	352	478.0	412.0	350.2	411.0	352.5	353.5	489.0	415.0
Hardness (mg/L)	200.7	244.0	199.0	211.5	275.0	200.0	207.4	250.0	198.0
Phosphate (mg/L)	0.5	1.0	0.0	0.5	1.0	0.0	0.2	0.8	0.0
Nitrate (mg/L)	1.5	5.9	0.0	0.4	2.5	0.0	2.5	8.1	0.0

Table 6. third Attempt After 15 days of Water quality parameters.

Locations	**Jamrao Canal** *n*= 5			**Jhudo** *n*= 6			**Pir Bodla Farm** *n*= 8		
Statistics	Average	Max	Min	Average	Max	Min	Average	Max	Min
DO mg/L	7.7	8.2	7.0	7.72	8.10	7.30	7.4	8.3	7
TDS (mg/L)	1090.7	1890.0	1600.0	1060.19	1899.0	1580	1093.6	1877.0	1580.0
EC (uS/cm)	1822.4	4070.0	620.0	1738.29	5260.0	550	1520.2	2990.0	778.0
PH	7.4	8.45	6.77	7.45	8.30	6.92	7.7	8.4	7.0
Turbidity (NTU)	27.0	32.1	29.3	25.38	21.26	18.10	27.92	33.0	15
Chloride (mg/L)	353.8	440	4100	352.06	410.0	350.9	354.5	491.0	414
Hardness (mg/L)	215.6	279	189	207.48	270.0	188.2	218.2	277.0	279.0
Phosphate (mg/L)	0.0	0.73	0	0.58	2.02	0.02	0.6	2.7	0.0
Nitrate (mg/L)	3.5	19	0	2.41	11.43	0	7.5	22.4	0.3

3.1.1. Electric Conductivity

As indicated in Table 4, we measured conductivity values in our study that ranged from 250 uS/cm to 7190 uS/cm, and their average maximum values were 2150 mg/L, which were over the usual recommended limits. TDS concentrations are higher in zones with the highest average EC [32]. Agricultural runoff and sewage leakage from sizable drains in both zones, such as Pakistan's Right Bank Outfall Drain (RBOD), a drainage canal on the right bank of the Indus River, and Left Bank Outfall Drain (RBOD), a drainage canal on the left bank of the Indus River, may be to blame for this. More than two million hectares of land are drained into the Arabian Sea by both canals, which also collect industrial waste and floodwater from the Indus river basin. Additionally, Mancher Lake, a significant drinking water reservoir in south Sindh, was reportedly contaminated by these drains [35–37]. Surface water contamination is higher in urban regions than in rural areas, which is consistent with the earlier study [17] [38. [39] In contrast, high EC in central Sindh may also be caused by extensive evaporation of the water from a large canal area of the river and lakes at high atmospheric temperature. The Arabian Sea borders the southern part of the Sindh and contributes to the intrusion of saline water into the freshwater zone as a result of over-pumping for agricultural use. With nearly identical terrain and potential sources of contamination, similar results are reported in the drinking water of India [16].

3.1.2. Total Dissolved Solids (TDS)

During our investigation, TDS was found to range from 1260 mg/L to 2330 mg/L. In Jamrao Canal Sindh, the high average TDS level was between 1000 and 1250 mg/L, exceeding the WHO-recommended limits [23], and altogether, 33% of the samples had TDS concentrations above the threshold. The TDS results differed by location and water source (canal and surface) in these samples, which were drawn from community water sources rather than canals, which is consistent with our findings [7,40,41]. Although we considered both surface and canal water sources, some studies in the same study population (community settings) found different results. These findings may be related to water treatment, different study methods (small sample size, sampling technique, non-representative sample, etc or a focus on only the surface water sources of water [42,43].

The study province (Sindh) continues to have a primarily arid environment with very little annual rainfall, averaging just 200 mm, leading to little variance in water quality indices. In this area, natural processes such ion exchange in the aquifer and rock solubility have significantly contributed to rising EC and TDS levels [43], which were observed in our study samples (Tables 4 and 5). comparatively, the increase in TDS and EC concentration in canal water source rather than other indicates industrial and residential wastewater contamination which possibly mixes into surface water [7,35]. Unwanted gastrointestinal discomfort and physiological reactions may result from the excessive TDS effect on drinking water flavour. Prior studies in this area have also discovered high EC and TDS levels, which raises serious concerns regarding the health of the children in Sindh province.

3.1.3. pH

The pH levels in drinking water are within the WHO criteria, according to earlier studies on water quality in community settings [7, 41]. The average pH readings in our study fell between 7 and 8, which is within the limit advised by both the Pakistani EPA drinking water quality guidelines [22,23] and the WHO (Figure 3). The average pH value was 7.6, while the pH ranged from 6.77 to 8.7, with Central Sindh at 6.8 and South Sindh at 8.7. (Tables 4–6). However, the pH frequently has no direct impact on water consumers (children), but it may have an indirect impact on health.

Our drinking water samples had neutral to alkaline pH, which may be caused by the dissociation and weathering of carbonate rocks and HCO_3^- that are present in the research area [40,46]. Elevated levels of HCO_3^- can also result from the weathering of carbonaceous rocks [18,30]. The high pH of the water may irritate mucous membranes, eyes, and skin. Additionally, it might have an impact on the effectiveness of disinfection and the level of metal corrosion [30,44]. According to our investigation, severe corrosion of water supply pipes may not be caused by an alkaline pH.

3.1.4. Turbidity

In our investigation, the range of turbidity's average maximum concentration (15–33 NTU) was noted (Tables 4–6). The canal's drinking water exceeds the WHO standard. Apart from the difference in study settings (community rather than canal settings), previous studies in community settings showed little variation in the results, which may be due to the smaller sample size and non-representative sample (rural specific or urban specific) in those studies [11,40,45,46]. According to our study, as pathogens attached themselves to the suspended particles in the turbid drinking water, the schools in South Sindh with high turbid water are also more susceptible to microbiological contamination. The pathogens are therefore protected from disinfectants by these suspended particles, which also disrupt the disinfection procedure [45,47].

3.1.5. Chloride

In our investigation, chloride concentrations ranged from 350.9 mg/L to 491 mg/L, with 300-351 mg/L being the highest average concentration (Table 4). Overall, chloride levels were higher than required (Figure 3). According to the current study, children who are exposed over an extended period of time to the Jamrao canal may get difficulties with their hearts, kidneys, or liver. In particular, when chloride and sodium combine to generate sodium chloride, which can damage piping, water heaters, and other appliances and cause harmful metals to leak into drinking water [30], the high chloride level can also cause corrosivity reverse osmosis (RO) in drinking water treatment systems, however, makes it simple to eliminate chloride contamination [23,32].

3.1.6. Hardness

The average hardness concentration (Tables 4-6) was 291 mg/L, which was still within acceptable limits, however some samples from all three zones were beyond the suggested limit [22,23]. Similar to chloride, sources of increased hardness are typically present. The availability of magnesium and calcium ions, which are mostly found in sandstone and are particularly present in limestone, is primarily indicated by the hardness of the water [31]. Our findings are in line with a local study [49] as well as research from Iran and India [16,17]. While the hardness content differs from studies done in other provinces, this could be because of the differences in the topography, the primary source of drinking water, or probable sources of contamination [14,44].

3.1.7. Dissolved Oxygen (DO) Nitrate and Phosphate

The average concentrations of DO (7.3 mg/L), nitrate (3.2 mg/L), and phosphate (1.3 mg/L), which are all the parameters combined, were within acceptable ranges [22,23]. These results agreed with previous research [11,40,41]. The statutory limit for phosphate and nitrogen is rarely exceeded, though. Sewage, runoff from livestock operations, and fertilisers are potential sources of contamination with phosphate and nitrate. In our study, rural communities with agricultural land and unimproved sewage systems had drinking water that was most susceptible to these toxins. Nitrate may leach into canal water through surface runoff when nitrogen in fertilisers is not absorbed by the plants, increasing the nitrate concentration in canal water sources. Additionally, half of the nitrate in the wastewater is removed by the canal with the septic systems, while the other half percolates into the groundwater. Increased nitrate levels in canal water may also be a sign of potentially dangerous household pollutants and other agricultural pesticides [11,40]. In our investigation, agricultural activities, the decomposition of animals, plants, and excreta, as well as untreated sewage discharge, were the main causes of nitrate contamination in both canal and surface water [31,32]. In the study's current contexts, agriculture activities mostly rely on the use of pesticides and fertilisers like urea, di-ammonium phosphate, etc., which eventually contaminate water resources.

3.2. Water Quality Index

3.2.1. Water Quality Index

The weight values assigned to each water quality indicator based on their respective importance for drinking reasons were used to calculate the WQI values for each sampling location (Table 2). According to WQI values [33,34], the drinking water quality was divided into five groups, as indicated in Table 3. This technique, which uses a list of factors and their concentrations to get a single value for rating water quality, is thought to be the easiest. This single value offers a comprehensive understanding of the water quality and its consumption (suitability) for many uses, including drinking, irrigation, and industry [41,46,49].

The WQI of the Canal (Figure 4) in Jhudo, Sindh, which predominantly utilised groundwater, indicated an overall good quality drinking water; nevertheless, the canal water is not appropriate for drinking purposes and must first be treated. where drinking water may be obtained from both surface and groundwater, there is good water. Of the three locations, Sindh's canal was the most vulnerable, with 50% of youngsters consuming poor or very poor to unsuitable drinking water, while Jamrao canal had the least access to clean drinking water (49%). Due to the dumping of municipal and industrial garbage, the drinking water quality along the seashore in Sindh's southern region has declined (Figure 2). Freshwater resources are also scarce in this region [50, 51].

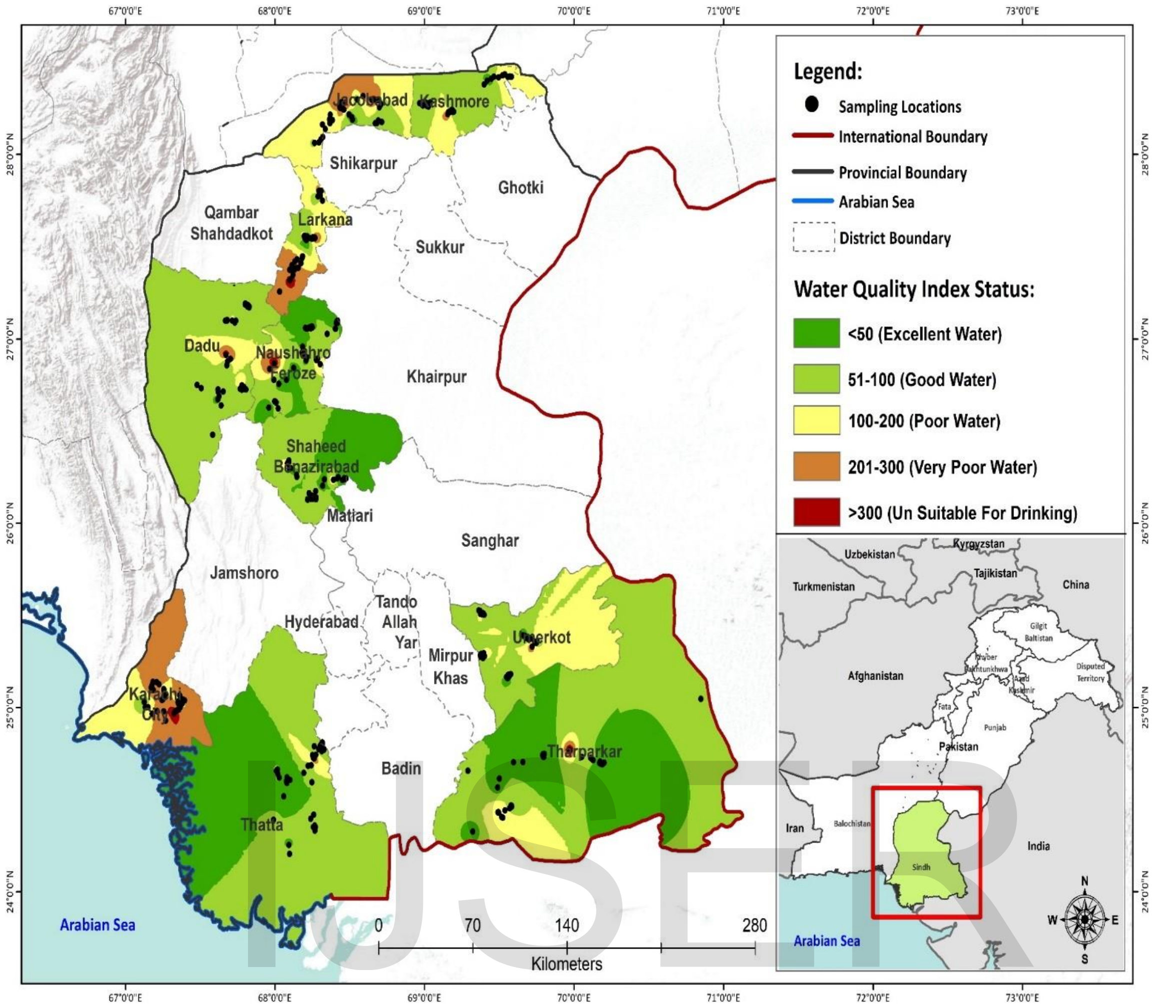

Figure 2. Water Quality Status of different areas of Sindh

3.2.2. Discussion on Water Quality Index

Comparatively to other canals with access to either good, extremely bad, or inappropriate drinking water, 95% of those who use water have access to water of a fair quality. Between these three places, there was, however, no discernible difference. Previous local research has shown that some areas of Sindh Province do not have drinkable water [7,40,50]. Variable outcomes have been observed in other research. A groundwater survey in Iran revealed that whereas 48% of the population drank water of low to unacceptable quality, 52% of consumers had exceptional or good drinking water [17]. According to a study conducted in south India, the quality of the water ranged from Excellent to Poor, and there were significant seasonal variations caused by the weather (temperature and rainy season) and pilgrims, who put a tremendous amount of strain on the provision of basic necessities like shelter, food, and waste disposal [19]. The majority of the samples from a similar investigation of drinking-water sources from canals were of fair quality compared to good quality at other locations, highlighting the large influence of diffuse and point sources of contaminants in these areas [38]. The results of these three studies are different from our study primarily because they concentrate on a single water source (canal or surface), use a different WQI methodology, have different climatic conditions, and have different sources of pollutants, such as industrial effluent as opposed to agricultural pesticides.

Water supply lines' condition, level of treatment, and water source quality are all factors that affect the quality of drinking water. Since most people in Pakistan lack access to fresh water sources and the groundwater is salty, students are forced to consume this type of water. Drinking water quality in canals does not satisfy WHO criteria [2]. The primary cause of water contamination in urban areas is the mixing of sewage lines with drinking water supply lines, whereas facilities for water filtering are accessible in rural areas where surface water is used without pre-treatment. Additionally, surface runoff and flooding could damage the hand pumps and wells [24,46,49]. Ground and surface water quality have decreased due to wastewater discharge into natural water resources as a result of industrialization and fast urbanization [7,11,51]. These three locations with better water quality may have a safe natural groundwater source or better management systems, as well as additional support (related to WASH) from the government, community, or other organizations [6,9,52]. These schools may also have better management systems or more support from related organizations.

In our study, the quality of drinking water is further worsened in the distribution lines, possibly due to the leakage of water pipes at a point where the drainage water enters into the main drainage system [50,51]. At the canal level, drainage water may be contaminated due to uncovered overhead storage tanks, underground storage tanks, and unhygienic handling of water by consumers [46,47].

During the last decade, the overall drinking water quality of the studied area has been subject to a rapid decline for various reasons. First, as a result of climate change, water resources (quantity and quality) in Pakistan have deteriorated; water temperature has increased and, as a result, a marked change has been witnessed in rainfall patterns, the behavior of glaciers, and the occurrence of extreme events such as floods, droughts, and greenhouse gas emissions [52–54]. Secondly, increases in the population have increased the stress on water resources with more human activities compromising water quality [55]. Finally, the expansion of industries due to the transition of the country from an agricultural to a semi-industrial state contributes to the contamination of canal bodies, due to the lack of vigilant monitoring of industrial waste management systems [7,11,56]. The WQI tools have widely been used by investigators around the world for water quality monitoring in canal- or surface-water sources, but not purely on drinking water settings in a large study setting, or by considering both canal and surface water sources serving these schools.

A few restrictions applied to our investigation. Since we only considered one water sample from each primary school, we presuming seasonal variation in water quality; consequently, some of the WQI values might be strongly affected by variations throughout the year, and we suggest that this work must be improved by collecting data over a longer period to identify these processes and their effects. Additionally, we evaluated the WQI tool's water quality based solely on physicochemical factors. In order to understand drinking water quality in canal settings better, future studies should take metals and microbiological characteristics into account.

4. Conclusions

In order to evaluate the drinking water quality, we looked at the spatial distribution of WQI in Pakistan's Sindh province's Jamrao canal using physicochemical characteristics. Widely used as a quick and simple tool to evaluate the overall quality of water, the WQI in this study, drinking-water quality was assessed in Jamrao canal settings for the first time using the WQI approach. Only one-third of the canals provide access to clean drinking water for children, according to the study's findings. The five main parameters that were discovered to be associated with poor water quality were EC, TDS, turbidity, hardness, and chloride. These parameters pointed to contamination of surface and groundwater sources through discharges from industrial, domestic sewage, residential, and agricultural runoff. To halt the spread of diseases associated with contaminated water, jamrao canal residents need better access to clean water and sanitary facilities. We advise continuous monitoring of drinking water sources and, when necessary, the adoption of low-cost, straightforward, and environmentally friendly methods of drinking water purification, such as chlorination, sun disinfection, and boiling. To acquire a better understanding of the drinking water quality in current settings, longitudinal studies that cover metals, microbiological, and physicochemical factors may also be taken into consideration in the future.

5. Recommendations:

I. It is not acceptable to dump municipal solid garbage into canal water bodies. The Sindh Irrigation and Drainage Department is solely in charge of preserving the quantity and quality of canal water, thus it will set up a routine inspection and enforcement system to encourage good judgement.

II. The sewer system in Jhudo Municipality has to be reviewed, and instead of using a canal to connect disposal stations to the drainage system.

III. All cattle farms should be made bound to adopt alternatives for prevention from disposal of animal dung etc. And vigilance should be kept upon poultry farms in order to stop illegal disposal of dead chicks into water body.

Acknowledgments: Financial support by department of civil engineering, Mehran University of Engineering & Technology Jamshoro, Pakistan, are acknowledged.

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