

## **Assessment of Source and Quality of Drinking Water in Coastal Area of Badin, Sindh, Pakistan**

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**Abstract:** Pakistan is a signatory to the Millennium Development Goals (MDG) and has a commitment and obligation to meet the targets relating to sanitation and water access to under privilege and underserved people of Pakistan that are vulnerable to the development of safe drinking water as per the standard of World Health Organization (WHO) and National standards. Poor people of coastal area are not only deprived of financial resources but they are lacking basic needs such as education, health and safe drinking water. Provision of safe drinking water in the coastal area is vital for reducing incidence of waterborne diseases such as diarrhea, malaria, trachoma and hepatitis A & B. Present study was, therefore, undertaken to assess the source and quality of drinking water in two Talukas of Badin district (Badin and Fazul Rahoo). The study areas as surveyed are not provided with drinking water through water supply and are mostly relying on groundwater and open ponds, causing various waterborne diseases and health problems. Coastal area of Badin being at tail end of the water source, having shortages of surface water in the system, compelling people to obtain water from distance i.e. from ponds and deep groundwater which is polluted and saline, making it unfit for safe drinking purpose. The results of survey revealed that 88% of the villages of coastal area are getting water from groundwater, while only 12% from the water supply schemes. On examination of physico-chemical analyses of 175 water samples from 49 villages of coastal area, it was found that 70% water samples contained various degrees of contamination above the threshold values of WHO quality standard; hence making water unsafe for drinking purpose.

**Keywords:** Badin, Coastal area, Drinking water quality, Groundwater, Health, NEQS

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### **I. Introduction**

Coastal area of Sindh province of Pakistan is under privileged, underserved and vulnerable to the development of water access and sanitation facilities. Up to 1960, it was prosperous due to various fertile resources but became poor when sea water intrusion led the groundwater and fertile lands saline due to diversion of waters of the Indus on the upstream and disallowing required flow downstream to the sea. As a result, agriculture and pasture lands turned into barren consequently affected livelihood of coastal area people (Panhwar et al. 2006).

The people of the coastal area of Badin have almost zero access to drinking water within the household level; they are the most marginalized and highly vulnerable. Along with other causes for the rampant malnutrition in the area, lack of safe drinking water is the critical issue (Phelps, 2003). The lack of safe drinking water is attributed to discharge of untreated wastewater and dumping of effluent in fresh water bodies (Sohag and Mahessar, 2005). It is estimated that 25-30% of all hospital admissions are connected to water borne bacteria and parasitic conditions, with 60% of infant deaths caused by water infections. The long term effects on human health of unsafe water and other pollutants include bladder cancer, miscarriage, birth defects, deformation of bones, and sterility (WHO, 1997).

Poor water supply services with lack of sanitation and highly degraded coastal environments are the most visible consequences of the many waterborne diseases. The coastal area of Badin has almost non-existent water supply and sanitation infrastructures. Resultantly, the population of coastal area is faced with unhygienic conditions malnutrition and exposed to waterborne diseases (Report on District Census of BADIN, 2001).

Coastal area is exposed to several crucial issues of safe drinking water and sanitation including saline and brackish ground water due to intrusion of sea water in the fertile lands, silty and polluted open irrigation

water channels, shortage of surface water, frequent rainfall flood and cyclone disasters, and lack of access to safe water supply and sanitation causing waterborne diseases (diarrhea, dysentery, jaundice, typhoid and cholera) commonly found in the area. Mostly children are widely affected due to consumption of the poor water quality of groundwater and open channels hauled by the women from long distance in the absence of effective community participation mobilization (Leghari, 2013).

The safe drinking water is essential for human survival as well as aquatic life. It is estimated that 75 % of the population of developed nations lack safe drinking water and adequate sanitary facilities and wastes are dumped into nearest body of flowing water (Memon 2005). World Health Organization estimated that 1.6 million deaths of children per year are attributed to unsafe drinking water, poor sanitation and lack of hygiene (WHO, 2003).

In Pakistan, it is estimated that 100-150 children die every day due to diarrhea infection caused by unsafe drinking water and unhygienic conditions, About 65 to 75 million people of 2010 census are lacking safe drinking water and sanitation. Urban and rural areas serve 92% and 89% of population respectively with water supply. As a signatory to the Millennium Development Goal, Pakistan has made significant progress in providing access to water supply but issue of safe drinking water as per WHO and National standards is still in question (SWA, GoP, 2012). Moreover, people are ignorant and unaware of hygiene and healthy drinking practices in homes also caused diarrhea and other diseases, particularly among children (DAWN, 2012).

## II. Description Of Study Area

The study area is limited to Talukas Badin and Fazul Rahoo of Badin district in coastal belt of Sindh province stretching 50 km and 50 km wide as shown in Figure 1. It is located at latitudes 24° 31' and longitude 68° 39' at an elevation of about 50 meters above sea level. The population of talukas Badin and Fasul Rahoo is 289,259 and 18,269 people respectively, which comes under coastal and Indus delta region.

The Indus Delta is low lying and bears the full force of the southwest monsoon. The entire coast in Sindh is spread over Badin, Thatta and Karachi districts. The delta, since ancient times, has shifted from northwest to the southeast, towards the sea, thereby creating new and fertile lands. Around 1500 A.D., the Indus Delta was reported to have 23 active creeks. Due to changes in the main course of Indus River in 1517 A.D and 1758 A.D, the delta has moved eastwards of Thatta. Several creeks on the right bank, including those around Karachi are now inactive. However, the Indus Delta is still reported to comprise 17 major creeks as shown in Figure 2.

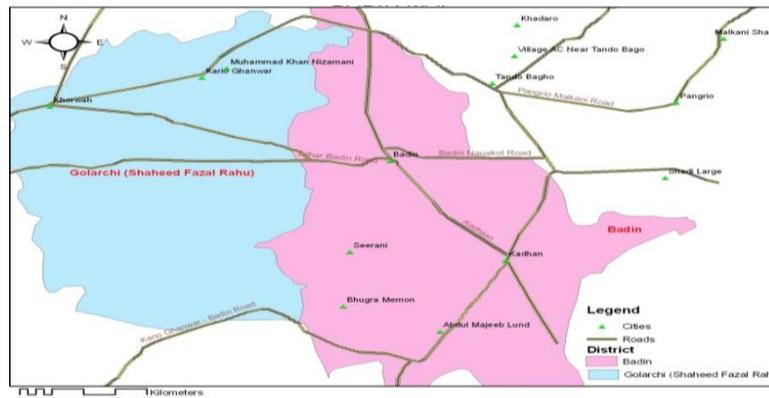


Figure 1: Study/project area

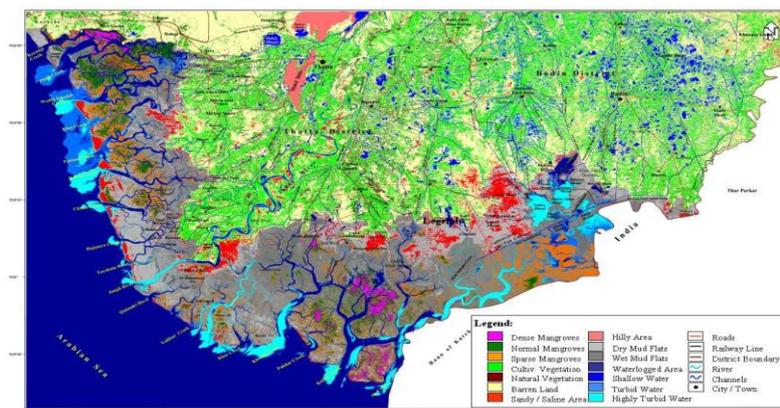


Figure 2: Creeks of Indus Delta and Coastal area Material and methods

The study area is located at the tail end of the Indus system along the coast line of Badin district. Being at tail end of irrigation system, the irrigation water is not adequate for supply of fresh water to the coastal zone area. Local community in the area therefore rely on groundwater or haul water from long distance, Due to sea intrusion, the quality of groundwater has deteriorated and fresh water from open channels is inadequate or unavailable, Hence, local community is facing problems of using unsafe water for drinking and domestic use causing various water related diseases and immature deaths in this area. This necessitated the comprehensive study of the area for establishing the status of water quality in relation to safe drinking water as per National and WHO standards,

### Data Collection

Survey of study area was carried out in Talukas Badin and Fazal Rahoo to identify the source of drinking water and to collect sample of water from randomly selected 14 and 35 villages of Taluka Badin and Taluka Fazul Rahoo respectively, representing the area. Total of 170 water samples were collected from study area, five each from selected villages. This way 70 and 100 water samples were collected from Taluka Badin and Fazul Rahoo respectively. The GPS coordinates were also recorded for each sampling location (see Fig. 3), which is developed using Global Mapper and Arc GIS softwares. This figure 3 shows locations of sample collection and name of villages.

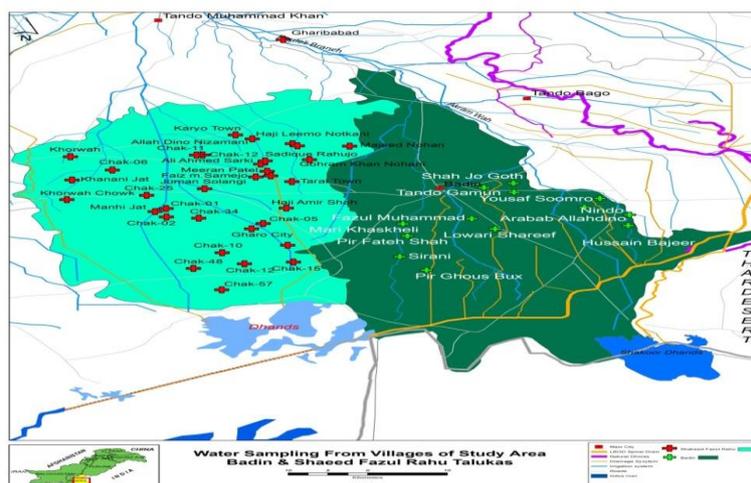


Figure 3: Locations of samples collection from 14 and 35 villages of Talukas Badin and Fazul Rahoo

Out of total samples, 75% water samples have been collected from hand pumps, 7% from water supply, 6% from taps and 3% from ponds (Fig. 4). Majority of water samples were collected from hand pumps while only few samples were collected from surface water open channels of taluka Badin. These water samples were collected in polystyrene bottles of 1.5 liter capacity for physico-chemical analysis. Before collecting the samples, the bottles were washed properly and rinsed thoroughly several times with distilled water. Nitric Acid and boric acid were used as preservatives in the sampling bottles for trace elements and nitrate (nitrogen). Samples were transported and brought to the laboratory of Pakistan Council of Research in Water Resources (PCRWR) which is located at Drainage and Reclamation Institute of Pakistan (DRIP), Tando Jam for analyses of microbiological, physico-chemical, Nitrate-Nitrogen and general water quality characteristics.

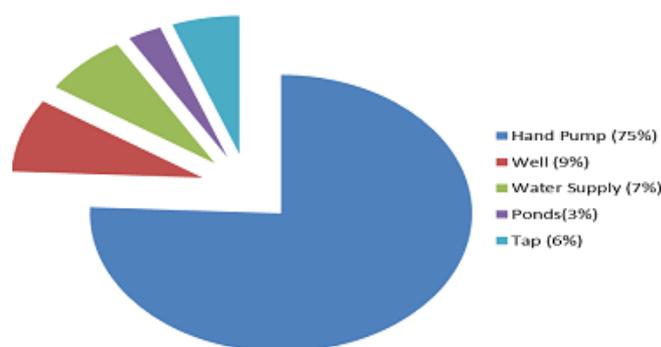


Figure 4: Source Distribution Of Water Samples From 14 Villages Of Taluka Badin

### III. Results And Discussions

The results of survey and analysis of water samples collected from two different talukas of Badin districts are presented in graphical form to show the status of water availability for drinking and domestic use and level of safety for drinking water compared to National and WHO standards.

#### Source Of Drinking And Domestic Water Use

From 14 villages of Taluka Badin, the survey results indicated that 78 percent households are using groundwater from which 71% are using hand pumps and 7% dug wells (Fig. 5) while remaining households are getting water through water supply schemes available in the area. It is obvious from results that majority of villages are depending on the groundwater and are deprived of water supply schemes in the Taluka Badin of district Badin.

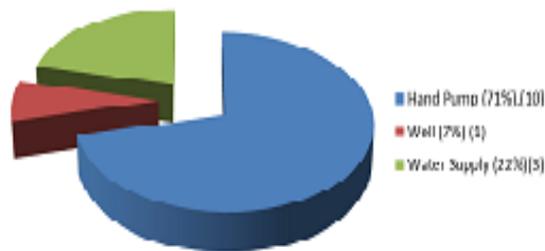


Figure 5: Source of drinking to 14 villages of Taluka Badin in coastal area

Similarly survey results of 35 villages of Taluka Fazul Rahoo revealed that 68 percent households of villages are using hand pumps, 23 percent dug wells and only 3 percent getting water through ponds for drinking and domestic use while remaining 6% households are merely getting water through water supply (Fig. 6). In this area, 94% households are deprived of water supply and majority rely on groundwater for drinking and domestic use.

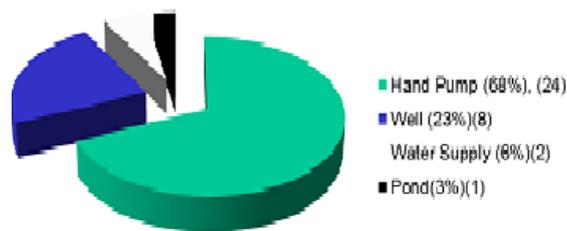


Figure 6: Source drinking water to 35 villages of Taluka Fazul Rahoo

Fig. 7 exhibits the results of 49 villages of study area revealed that the majority of households (88%) are dependent on shallow groundwater; only 10% households receive water through schemes. The shallow groundwater is being extracted through groundwater pumps and open wells. It is evident from the results that the coastal area is totally dependent on shallow groundwater since deep groundwater is saline, Very minimal households are provided water supply from Government i.e. only in urban area. Further analysis shows that the availability of surface water is erratic due to water shortages at the source. The water shortages in open channels limit the recharge of shallow groundwater further depriving the people of the coastal area of adequate drinking water.



Fig. 7: Overall source of drinking water to 49 villages of study area Water Quality

The results of physico-chemical analyses of total 245 water samples (70 from Taluka Badin and 175 from Taluka Fazul Rahoo) of study area have been compared with the National/WHO standards for assessment of the safety of drinking water.

Fig. 8 presents the results of turbidity, pH, total dissolved salts, chloride content, sulfate, sodium, potassium, magnesium and hardness of 70 water samples of Taluka Badin. Whereas Figures 9 and 10 present the results of Taluka Fazul Rahoo of Badin district.

**Turbidity:** Turbidity is a measure of relative clarity of water from suspended substances. High turbidity values in water samples may indicate the presence of micro-organism. The increase in turbidity may contribute in high coliform count and risk to human health. The results of Taluka Badin area (Figure 8) show that out of 70 water samples, 54 (77%) water samples found unfit due to turbidity values greater than 5 NTU as recommended permissible limit by WHO. The turbidity values ranged between 3 and 200 NTU (Leghari, 2013). In case of Taluka Fazul Rahoo area, 45% water samples contained higher turbidity level than the permissible limit (Figure 9).

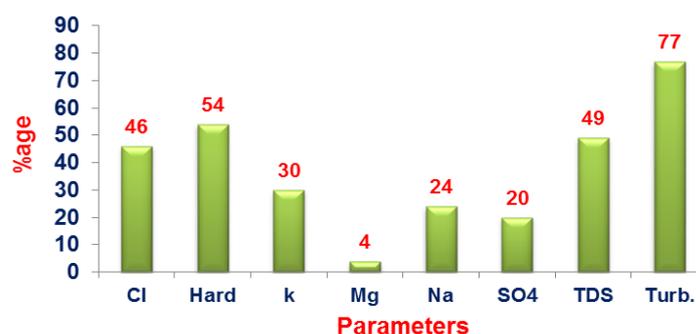


Figure 8: Level Of Contamination (%) Of Water Samples Collected In Taluka Badin

**PH:** The pH is the intensity of alkalinity or acidity condition of the water. Fresh water is always slightly alkaline due to presence of carbonates. The pH values of all the water samples from Talukas Badin (Fig. 8) and Fazul Rahoo were under permissible limit and safe for drinking water.

**Total Dissolved Salts (TDS):** Similarly, total dissolved salts (TDS) is a measure of inorganic salts and amount of organic substances present in water solution. The results show that TDS values were higher than permissible limit (1000 mg/l) in 49% of the samples (34 of 70 water samples) from Taluka Badin (Figure 8). Whereas 47% water samples in Taluka Fazul Rahoo were found unfit for safe drinking water due to higher TDS values than the permissible limit set by WHO (Figure 9).

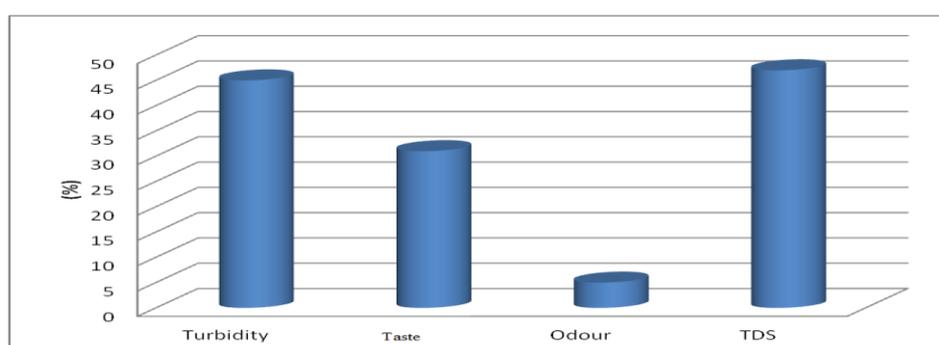


Figure 9: Number Of Unsafe (%Age) Water Samples Collected In Taluka Fazul Rahoo

**Chloride Content (Cc):** In case of chloride content (CC), 46% water samples of Taluka Badin contained higher CC values as compared to permissible limit of 250 mg/l (Figure 8). Similarly 47% water samples of Taluka Fazul Rahoo were unfit for safe drinking water due to higher chloride content than the permissible limit (Figure 10). The measured chloride content was in the range of 74 and 1325 mg/l (Leghari, 2013). Increase of chloride content beyond the safe limit does not pose any significant health problem except the test.

**Sulfate Content (SO<sub>4</sub>):** In Taluka Badin area, sulfate content (SO<sub>4</sub>) was higher than the permissible limit of 250 mg/l in 20% of water samples (Figure 8). Whereas in Taluka Fazul Rahoo 37% water samples contained higher sulfate level than the recommended limit by WHO (Figure 10). The concentration of sulfate

was measured which vary from 07 to 1305 mg/l An increase in sulfate level from the recommended level may cause diarrhea due to ingestion of water specially to general population that may be at risk from laxative effects of sulfate.

**Bi-Carbonate (HCO<sub>3</sub>):** All the water samples from both the areas were not detected higher Bi-carbonate values and were under the permissible limit of 1000mg/l. The level of bi-carbonate in all water samples found within 150-450 mg/l.

**Total Hardness (TH):** Hardness of water occurs due to entry of water through leaching process of rocks and its high content may cause hardness of water. According to WHO, the hardness should not exceed 500 mg/l. The analysis of the results of Taluka Badin shows that 38 water samples (54%) found higher hardness of water than the permissible level (Figure 8). High TH beyond the permissible limit was found in 47% of water samples from Fazul Rahoo area (Figure 10).

**Cation:** The analysis of the results of cation of Badin indicate that 17 water samples (24%) found unfit due to high content of sodium, 21 (30%) of water samples contained high potassium level whereas only 03 (4%) water samples measured high magnesium level crossed the safe limit of drinking water (Figure 8). The safe limit of Na, K and Mg as recommended by WHO for human consumption is 200, 12 and 150 mg/l respectively. Similarly, the results of Fazul Rahoo area revealed that 52% water samples were unfit due to high level of sodium, 32% because of high Potassium level and 30% due to high content of magnesium level (Figure 10).

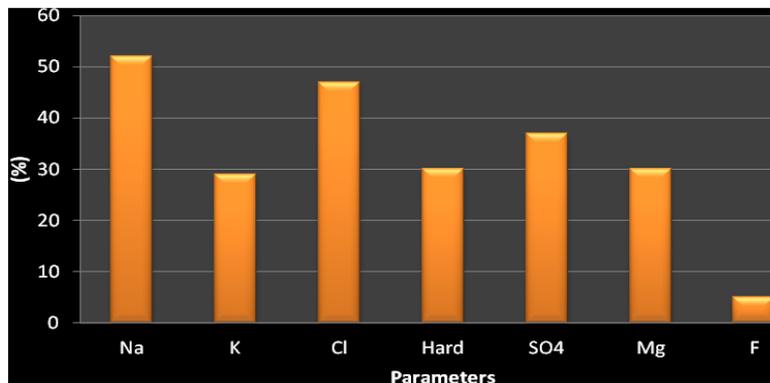


Figure 10: Number Of Unsafe (%Age) Water Samples Collected In Fazul Rahoo

**Nitrogen-Nitrate (NO<sub>3</sub>):** Ground water in the coastal area is exposed for over use of fertilizer for agriculture which may result in contaminating shallow groundwater aquifer with Nitrite which is toxic for human health. The results show that the nitrate-nitrogen was not detected in all water samples from both Badin and Fazul Rahoo areas.

In addition, iron and arsenic concentration in both areas found within safe limits as recommended by WHO for drinking purpose. The safe limit of arsenic as set by WHO is 50 ppb. Only 5% water samples of Fazul Rahoo area found higher fluoride content than the permissible limit whereas fluoride content of all water samples of Badin area were under the permissible limit (Figure 8 and 10).

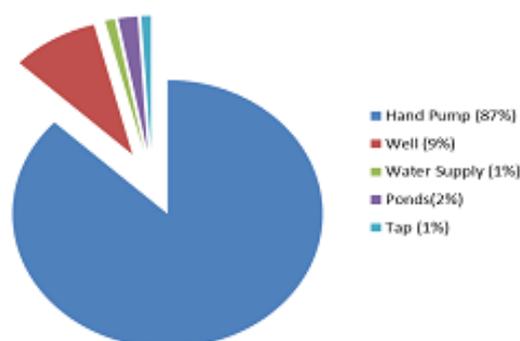
As a result of physico-chemical analysis of both the coastal areas, it was found that water quality of drinking water of Talukas Badin and Fazul Rahoo areas was unsafe due to higher contamination than the permissible limit for 77% and 62% of water samples respectively (Figure 11).



Figure 11: Overall Situation Of Drinking Water Quality For (A) Badin (B) Fazul Rahoo

Therefore, only 23 and 38% of water samples passed the criteria of permissible limit for safe drinking water as set by WHO in Badin and Fazul Rahoo areas respectively.

Overall the drinking water of 70% water samples of coastal area is not safe and unfit for human consumption. Present results warn that the coastal zone needs to be provided safe drinking water which is fundamental right of people of the area for their health and environment.



**Figure 12: Collected 100 Samples From 35 Villages From Taluka Fasul Rahoo**

#### **IV. Conclusions**

The results from study of water samples of coastal area zone revealed that 88% of the area is receiving water from shallow groundwater source and only 12% have the facility of water supply.

The physico-chemical analyses of 175 water samples collected from 49 villages of coastal area (Talukas Badin and Fazul Rahoo) concludes that only 30% water samples contained safe drinking water in accordance with the permissible limit as set by WHO but 70% water samples were found unfit due to presence of turbidity, TDS, chloride content, sulfate, sodium, potassium, magnesium and hardness at high level than the permissible level for drinking water. Comparatively safe drinking water of Taluka Badin is slightly better than Taluka Fazul Rahoo.

Coastal zone is the most under privileged and underserved area require attention of Government as being the signatory of MDG for their fundamental right to receive safe drinking water for protection of health and environment. There is urgent need to work out detail plan for sustainable development of safe drinking water to the coastal zone.

It is suggested to develop an alternative plans for groundwater recharge and water quality through rain harvesting and micro filtration treatment for improvement of water quantity and quality for safe drinking water to the local communities in coastal area.

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