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Status of Water Bodies and Their Effect on Human Health in District Tharparkar

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Abstract: Studies were conducted to investigate the status of water bodies and their effect on human health in district Thar adjoining the Arabian sea coast, with very saline underground water. Water samples were collected from representative water bodies. In all, 95 water samples were collected from Dug wells (79), Hand/Motor pumps (9), Water supply schemes (4), Canal water (2) and Tanko (1). The samples were analyzed for pH, Electrical Conductivity (EC), Dissolved Oxygen (DO), Total Suspended Solids (TSS), total coliform count, turbidity, alkalinity, hardness, phosphorus, copper, manganese, iron, zinc and sodium. It was found that most of the samples were contaminated with coliform bacteria, had higher TDS, pH, EC, hardness, alkalinity, iron and manganese and phosphate concentrations compared to the standard permissible limits.

Keywords: Thar, Coliform, Electrical Conductivity, Drinking Water, Water Pollution, Tanko

Introduction

Water is a basic, indeed an absolute requirement for the survival of human race. An adequate supply of good quality safe water is essential for the promotion of public health. Generally, in less developed parts of the world and particularly in tropical areas, the health hazards caused by polluted water supplies are more numerous and more serious than those in temperate and more developed areas of the world. Water for domestic use should be clear, colorless, odor less, pleasant to drink and reasonably cool and free from impurities harmful to health. It is very well known that human health and survival depend on use of uncontaminated and clean water for drinking and other domestic uses.

District Thar of Sindh province which adjoins the Arabian sea coast have underground water completely saline due to sea water intrusion. In desert areas outside Indus basin, either harvested rainwater is used for drinking purpose or the public is compelled to use the underground saline water from wells for drinking, domestic use and for animals. Ground water in the Indus basin is of variable quality. It is non-saline near sources of recharge, i.e. rivers and major canals but gradually becomes saline with depth as the distance from the recharge source increases. Large-scale withdrawal of ground water is creating differential zones resulting in lateral and vertical movement of saline water into fresh water zones. Hence, if corrective measures are not taken, this situation is likely to pollute non-saline aquifer zones (Shaikh and Khan, 1995).

In Pakistan, despite of high mortality rate especially in infants due to the use of unsafe drinking water, no attention is being given to the drinking water quality improvements. Neither the public nor even the planners are well aware of the gravity of drinking water situation (Tahir *et al.*, 1998). The impurities accumulated by water throughout the hydrological cycle and as a result of human activities may be both in suspended and dissolved form. The size of dissolved particles range from 10^{-8} to 10^{-6} mm, the size of colloidal particles range between 10^{-3} to 10^{-6} mm whereas the suspended or non-filterable solids range from 10^{-1} to 10^{-3} mm size. Impurities could also be classified as organic, inorganic and living organisms (Peavy *et al.*, 1985). These impurities are detrimental to health, but if corrective measures are taken, the risk of damage to the health decreases to a larger extent. Martapura River of Indonesia was contaminated with total coliform, E-coli and hydrogen sulfide, but when that water was chlorinated with 0.1 mg/l, no coliform or hydrogen sulfide producing bacteria were detected (Chandio *et al.* 1998).

Present research study was aimed to investigate the status of water bodies in district Thar. Representative samples of water were collected and analyzed to ascertain the effect of the water on human health. Suggestions were put forth to minimize the pollution of water bodies in order to avoid the risk to the health of people.

Materials and Methods

Ninety five water samples were collected from different sources of water bodies representing canal water (2), hand/motor pumps (9), dug wells (79), water supply schemes (4) and tanko (1). The main source of water in Thar is dug well. Samples were collected in glass stoppered bottles leaving no air in the bottle (for dissolved oxygen) and in ½ plastic containers for other determinations. Before collecting the samples, the containers were sterilized in laboratory at 15 lb pressure and 121°C temperature for 15 minutes. The containers were filled with water samples from respective water bodies leaving 1/4th space empty and were labeled properly. Total dissolved solids and pH were recorded on the spot with portable TDS and pH meters respectively. Samples were refrigerated and next day tested for Dissolved Oxygen (DO), Total Suspended Solids (TSS), coliform count, turbidity, alkalinity and electrical conductivity. Remaining tests were conducted in couple of days later.

The electrical conductivity of samples was determined in laboratory using portable Electrical Conductivity meter. However the past research indicate a relationship of TDS=0.5 x EC at low salt concentrations to TDS=0.9 x EC at high salt concentrations (Jackson *et al.*, 1989)

Dissolved oxygen was determined using Azide Modification Method based on the addition of divalent manganese solution, followed by addition of strong alkali to the water sample in a glass stoppered bottle. Dissolved Oxygen present in the sample rapidly oxidized an equivalent amount of dispersed divalent manganese hydroxide (Eaton *et al* 1995).

Total suspended solids were measured by filtering the water through a 0.45 μm membrane filter placed in filtration assembly. The membrane was removed and transferred to a china dish. The dish with membrane was dried in an oven at 105° C for 1 hour and cooled in a desicator and weighed immediately (Eaton *et al.* 1995). The total suspended solids were calculated:

TSS (mg/l) = (B-A) x 100 / Volume of sample

Where

A=Weight of membrane + china dish

B=weight of membrane + china dish + residue

The alkalinity of water sample was determined by titrating it with strong acid first to pH 8.3 using phenolphthalein as an indicator and then further to pH between 4.2 - 5.4 with methyl orange. The former is called P-Alkalinity and the later M-alkalinity or Total Alkalinity. The concentration of carbonates, bicarbonates and Hydroxyl ions was determined from standard tables (Eaton *et al.*, 1995).

The hardness was measured directly by titration with Ethylenediamine Tetracetic acid (EDTA) using Eriochrome Black T (EBT) as an indicator. The EBT reached with divalent metallic cations forming a complex that was red in color. The EDTA replaced the EBT in the complex, and when the replacement was complete, the solution changed from red to blue (Eaton *et al.* 1995).

Sodium was directly determined by using Flame Photometer. A calibration curve was made with a Standard series of 0-100 ppm. The concentration of metallic elements (copper, iron, manganese and zinc) was determined directly by Atomic Absorption Spectrophotometer (Shimaduzu AA-670). Phosphorus was determined by molybdophosphoric blue color using ascorbic acid method (Murphy and Rilley 1962).

The presence or absence of coliform group of bacteria was determined by "multiple tube fermentation technique". As the coliform organism was known to ferment lactose, the fermented samples produced gas and acidic reaction (shades of yellow colour). The positive samples showed presence and negative the absence of the coliform group of bacteria. The MPN index/100 ml was determined from standard tables (Eaton *et al.*, 1995).

The turbidity of water samples was determined using a turbidimeter working on Nephlometric method. This method is based on a comparison of the intensity of light scattered by the sample under defined conditions with the intensity of light scattered by a standard reference suspension under the same conditions.

Results and Discussion

The quality of drinking water and the status of pollution of water bodies were evaluated on the basis of the quality standards as suggested by the PCRWR (Table 1) on the guidelines of WHO, Public Health, Planning Department experts and PCSIR (Chandio *et al.* 1998).

The data in Table 2 depicted that 92 out of 95 samples had EC above highest desirable level. 100% samples from hand/motor pump, dug well and tanko had the EC above the highest desirable level of 400 :S/cm. This indicated that samples were highly polluted with dissolved solids to the extent that all samples had higher EC than the required.

pH values of canal water and tanko were 100% polluted, while 75% of water samples collected from water supply schemes, 44% samples of hand/motor pump and 43% samples from dug wells were found polluted. High calcareous nature of the soil of the area was believed to be the main reason for high pH of these water bodies. Thus 46% of total water bodies possessed higher pH value than the highest desirable level.

Dissolved oxygen level was satisfactory. Water samples collected from canal waters, water supply schemes and Tanka had adequate dissolved oxygen level. However, only 11% samples from dug wells and 5% samples from Hand/motor pumps had dissolved oxygen less than the minimum permissible range.

Sixty three samples had TDS above maximum permissible level (MPL) of 1500 ppm. The water above 100 ppm starts changing the taste. All the samples above 1500 ppm were either brackish or saline in taste. The polluted samples were 56% from hand/motor pump, 71% from dug well and 50% from water supply. The TDS of dug wells was as high as 8800 ppm, which was unbelievable. It was noted that TDS had correlation with both EC (r^2 = 0.9856) and sodium (r^2 = 0.8327) as shown in Fig. 1 and 2.

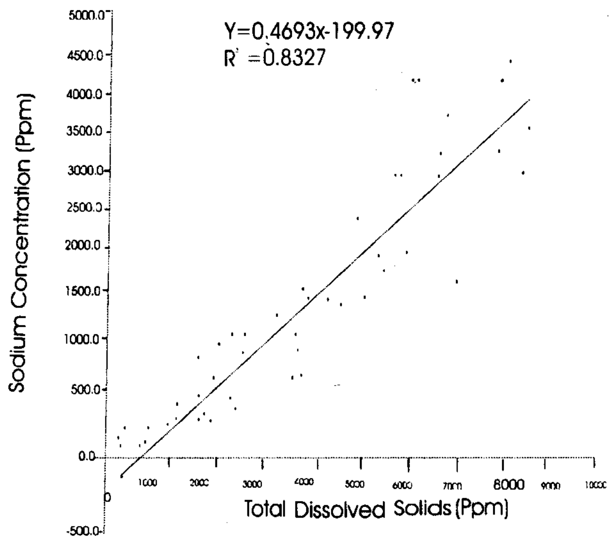

Fig. 1: Relationship of TDS with Sodium in Drinking Water Samples in Thar

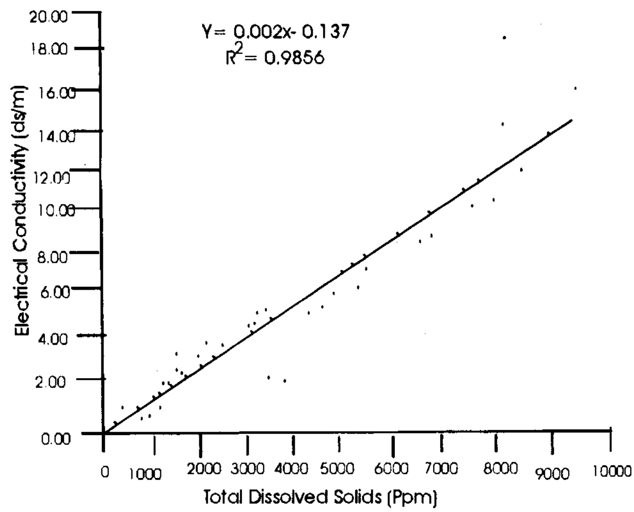

Fig . 2: Relationship of TDS with EC in Drinking Water Samples in Thar

The data for alkalinity revealed that 54 samples out of 95 had higher alkalinity than the maximum permissible limit. Almost half of the samples taken from the dug wells had higher alkalinity level. As most of the people use dug well water for domestic purpose, the present situation therefore called for immediate remedial measures.

The total polluted samples with regard to hardness were 39. It was observed that 44, 43, and 25% water samples were found polluted from hand/motor pump, dug well and water supply schemes respectively. Due to high availability of Ca and Mg ions, the dug wells crossed the maximum permissible level (MPL).

The data revealed that the samples were highly polluted with significantly high levels of sodium. The samples from canal water, tanko and dug wells were almost 100% polluted followed by hand/motor pump (89%) and water supply schemes(75%).

The data presented in Table 2 showed that only 3 samples out of 95 exhibited a higher concentration of manganese than the maximum permissible level of 0.5 mg/l while all others had manganese within permissible limits.

Concentration of coliform count is often represented as most probable number (MPN)/100 ml. The data gave most probable population of coliform bacteria in 100 ml water sample. Ninety-one samples out of 95 were contaminated. It was observed that almost all water bodies showed 100% coliform bacteria. The presence of coliform was a danger signal of the probable presence of very dangerous type of disease causing organisms.

All the water samples had iron, copper, zinc, phosphorus, Total Suspended Solids (TSS) and turbidity within permissible levels. Although, the canal water samples were found loaded with colloidal matter and soil particles but by the time it was used for drinking, most silt and colloidal matter got deposited and the suspended solids were within permissible range.

Use of dug well brackish and saline water in rural areas of Thar district is rather traditional. The rural people of Thar have only two options either to use rain harvested water collected in low laying (Taraees) areas, or when no rains, use the water from the dug wells. The wells having relatively sweet water are used commercially. A "PAKHAL" (150 liters) is sold at Rs.12/- to Rs.20/-. The water supply of Mithi had TDS of 5900 ppm and of the Deeplo 8800 ppm. The water from water supply was only used in cloth washing and bathing, not for drinking and cooking, but that too is uneconomical as it increased the use of soap many fold.

Some wells in rural areas were 200-250 feet deep. Camels, bullocks, donkeys or group of women were engaged to take water buckets from that depth. Fig. 1 shows the bullocks delivering water from well. The situation needed special attention. Enormous time and effort was wasted in taking the saline water from wells.

Table 1: Drinking Water Quality Standards for Physical, Chemical and Microbiological Analyses

Parameter	Unit	Highest desirable level	Maximum permissible level	Undesirable effects
Turbidity	NTU	2.5	5	Unaesthatic decreases efficiency of dis-infection
Taste & Color	-	Unobjectionable	Unobjectionable	Taste & Odor
TDS	Mg/l or ppm	500	1500	Salty taste, corrosion or instruction
Iron	Mg/l	0.1	1.0	Taste, discoloration
Manganese	Mg/l	0.05	0.5	Taste, discoloration
Copper	Mg/l	0.05	1.5	Taste, corrosion of pipes & utencil taste
Zinc	Mg/l	5	15	Taste
PH	-	7.0-8.5	6.5-9.2	Taste, corrosion
Hardness	Mg/l as $CaCo_3$	200	500	Corrosion, scale formation & economic loss to users
Alkalinity	Mg/l as $CaCo_3$	-	-	Bitter taste
Dissolved Oxygen	Mg/l	5 mg/l		No direct effect
Sodium	Mg/l	200		Taste, vomiting, muscular twitching, hypertension
Coliform	MPN index/100 ml	Must not be present in 95% of the samples taken throughout any 12 months period		Diarrhea, dysentery, stomach and intestinal disturbance etc.
Phosphates	Mg/l	0.4	5	Indirect effects, promote aquatic life
EC	μS/cm	400	-	Salty taste & corrosion

Table 2: Status of Drinking Quality of Selected Water Bodies for Various Parameters in District Thar of Sindh Province

Nature of water body	EC	pH	DO	TDS	Alkalinity	Hard-ness	Na	Mn	Coliform Count
	dS/m				Mg/l				MPN/ 100ml
Canal water	0 (0)	2 (100)	0 (0)	0 (0)	-	0 (0)	2 (100)	0 (0)	2 (100)
Hand/motor pump	9 (100)	4 (44)	1 (11)	5 (56)	3 (3)	4 (44)	8 (89)	2 (22)	9 (100)
Dug well	79 (100)	34 (43)	4 (5)	56 (71)	49 (52)	34 (43)	76 (96)	1 (1)	76 (96)
Water supply	3 (75)	3 (75)	0 (0)	2 (50)	1 (1)	1 (25)	3 (75)	0 (0)	1 (100)
Tanko0*	1 (100)	1 (100)	0 (0)	0 (0)	1 (1)	0 (0)	1 (100)	0 (0)	1 (100)
Total	92 (97)	44 (46)	05 (5)	63 (66)	54 (57)	39 (41)	90 (95)	03 (3)	91 (96)

Note: Values in parenthesis show percent

* Tanka is a cemented underground container for storing the rain water for future use.

Conclusions

Following conclusions are drawn from the analysis of the samples of drinking water collected from water bodies of Thar district.

- Out of 95 water samples, 44 samples had higher pH than the highest desirable level (HDL) of 8.5. These samples were more alkaline and had bitter taste and corrosive characteristics.
- The total dissolved solids of 63(66%) water samples were higher than the maximum permissible level (MPL) of 1500 ppm. These were polluted with various salts that would certainly affect the health of human beings.
- About 95% samples had dissolved oxygen level above normal range. However, 5% samples had D.O level less than 5 mg/l. Lower oxygen level indicated that the water bodies were not well aerated or there was microbial activity going on that caused oxygen depletion.
- Thirty nine of the lot of 95 water samples had hardness above the MPL of 500 mg/l. Pollution due to hardness had created problems in soap lathering thus caused nuisance for the poor people.
- MPL of sodium in drinking water is 150 mg/l. Out of 95 samples, 90 exhibited higher concentration of sodium. In places, where the sodium content in water bodies was high, the people complained of kidney problems and hypertension.
- Over 97% of the water samples crossed the guide level of 400 µS/cm Electrical Conductivity (EC). As the TDS and EC are mostly inter-dependent, their effect on human health was unavoidable.
- Almost 96% water samples were found completely contaminated with coliform group of bacteria. This is an alarming situation when almost all the water bodies in human domestic use were found loaded with coliform bacteria.
- Out of 95 water samples, 54 had alkalinity higher than 200 mg/l as Ca Co3, which indicated that the samples were alkaline in nature and had a different taste than normal waters did.
- Only 3% water samples had higher manganese level than MPL of 0.5 mg/l. The remaining samples were within the normal range.
- Graphs exhibited a positive relationship of TDS with sodium concentration and TDS with electrical conductivity with r^2 value more than 0.9.

Recommendations

- The areas, where underground water is brackish / saline, and no other source of drinking water exist as in Thar district; the government may initiate schemes that utilize pressure membrane or distillation techniques to desalinize and disinfect the under ground waters to be used by the people of these areas for drinking.
- Water supply schemes may be provided at least to the densely populated villages and sweet water wells should be dug in all the far flung areas after careful survey of the area taping sweet water to facilitate the poor people of the district, who at present are compelled to drink brackish underground water with TDS as high as 8000 ppm or more.

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