Pak. J. Engg. & Appl. Sci. Vol. 13, July., 2013 (*p.* 110-117)

A Study of Water Quality of Sargodha City

Sajjad Haydar[1] and Malik Muhammad Qasim[2]

1. Professor, Institute of Environmental Engineering and Research, University of Engineering and Technology, Lahore, Pakistan 54890.E-mail: sajj@brain.net.pk; sajjad@uet.edu.pk
2. Assistant Engineer, Millitary Engineering Services, Sargodha.

Abstract

A study was carried out to evaluate the water quality of Sargodha city water supply system. Water samples from four different sources (1 tubewell and 3 surface water sources) and eight house connections (2 from each source respectively) were collected making a total of twelve sampling points. Two set of samples, one before monsoon and one after monsoon were collected from each sampling point. A total of six parameters (four physiochemical; turbidity, pH ,hardness ,total dissolved solids and two bacteriological; total coliforms and faecal coliforms)were tested for each sample and compared with World Health Organization (WHO) guidelines for drinking water. The results of the study demonstrated that physical and chemical quality of all sources, except the New Satellite Town, was satisfactory. However, bacteriologically, all the source samples, except the tubewell source showed contamination before and after the monsoon. In the distribution system, physiochemical characteristics of all samples, except the New Satellite Town house connections, were satisfactory. Bacteriologically, all the samples from house connections were contaminated before and after the monsoon. It was concluded that inadequate treatment and no disinfection were responsible for bacteriological contamination at surface water sources. Possible causes of contamination at house connections were no disinfection, poor, old and leaking water lines along with inadequate and poorly maintained sewerage and drainage system. It was recommended that proper water treatment especially effective chlorination with residual chlorine be rendered at all sources in order to achieve safe water quality up to the consumer's end.

Key Words: Water quality; Sargodha; Physiochemical characteristics; Bacteriological characteristics.

1. Introduction

Water in its natural form contains suspended impurities including microorganisms and dissolved impurities. Other pollutants can also be added to water through human activities [1]. Historically, water and human health have been strongly related to each other. Water borne and related diseases have been the major cause of human morbidity and mortality [2]. These diseases are caused by pathogens. Water acts as a vehicle or medium for the transfer of these organisms to humans. So it has been proved that water quality and human health have been strongly associated with each other [3].

Problem of water pollution is more pronounced in the developing countries. Pakistan is an example of that. Pakistan like other third world countries has been facing water quality issues. Situation is more severe in urban areas of the country. This has been a challenge for municipal authorities in Pakistan to provide clean drinking water along with other necessities of urban life. Both surface and groundwater are used for providing water supplies in urban areas. Pakistan's population has a current water supply coverage of 79% [4]. Pakistan Council of Research in Water Resources in a study conducted on water samples collected from 32 cities of Pakistan revealed bacteriological contamination and presence of some highly toxic elements. Two million people in Pakistan have been affected by water with high arsenic concentration. About 2,50,000 children die every year in Pakistan due to contaminated water [5]. Contaminated water is responsible for 30 % diseases and 40 % deaths in the country [6]. People especially in urban areas have been severely affected by contaminated water e.g., in Hayderabad, 100 people died of gastroenteritis in 2004 [7].

The city of Sargodha is facing the same problem as areas which are being served by municipal water supplies. People are found complaining of deteriorating quality of water supply [8-9]. It is in this contest that the present study is being conducted to evaluate the water quality of Sargodha city.

2. Materials and Methods

2.1 Parameters Tested

Six water quality parameters; two physical, two chemical and two bacteriological were tested. Physical parameters tested were turbidity and pH. These two play a vital role in the disinfection process in water treatment. For effective disinfection turbidity should be 0.1 Nephlometeric Turbidity Units (NTU) and pH should be less than 8 [10].Chemical parameters selected were hardness and total dissolved solids (TDS). Hard water requires more soap to form lather. Water having high TDS may impart taste. High values of both these parameters cause scale deposition in pipes and utensils. No health based guidelines for all these physiochemical parameters has been proposed by WHO [11].

For bacteriological examination of water samples, total coliforms (TC) and faecal coliforms (FC) were the parameters selected. These are basically the indicators of bacteriological pollution [12].

All tests were conducted in accordance with the procedures laid down in the Standard Methods [13].

2.2 Sampling Area and Methodology

A portion of Sargodha city was selected for the purpose of this study. This area was divided into four portions namely Main city area, Zafar colony and Satellite area, Jauhar colony and New Satellite Town. Water to Zafar colony was supplied through a tube well installed along Lower Jehlum Canal (LJC) while water to Main City, Jauhar Colony and New Sattelite Town was supplies by taking raw surface water from LJC and applying sedimentation and slow sand filtration before supply. Each of this point of surface water source is called water works (W) in this study and is designated as W1, W2 and W3. A location plan showing the study area is given in Fig.1

Fig 1: Location plan of sampling points for the present study

Sampling points were selected both at source and consumer's end. Four sampling points were selected from the water sources i.e., 1 tube well and 3 surface water sources (W1, W2 and W3) and 8 house connections (2 from each water source), thus making a total of 12 sampling points. This sampling was based on criteria as per *WHO Guidelines 2004 i.e., 1 sample per 5000 heads of population.* A brief description of sampling points is given in Table 1.

Table 1: Description of sampling points for the present study

Sr. No	Sample Points	Description
1	T	Tube well installed along LJC
2	THC1	House Connection no.1 of T
3	THC2	House Connection no. 2 of T
4	W1	Main water works for main city area
5	W1HC1	House Connection no. 1 of W1
6	W1HC2	House Connection no. 2 of W1
7	W2	Water works for Jauhar colony
8	W2HC1	House Connection no. 1 of W2
9	W2HC2	House Connection no. 2 of W2
10	W3	Water works for New Satellite town
11	W3HC1	House Connection no. 1 of W3
12	W3HC2	House Connection no. 2 of W3

To incorporate any effect of monsoon rains, the sampling was done at each sampling point before and after the monsoon in compliance with WHO Guidelines. For statistical significance of the results the sampling was done 3 times before monsoon and 3 times after monsoon as shown in Table 2. In this way a total of 72 samples were collected and tested. Mean values of the three samples are reported in this paper.

Table 2 Sampling Schedule

	Before Monsoon			After Monsoon		
Sample No	1	2	3	1	2	3
Sample Date	11-5-09	26-5-09	10-6-09	10-8-09	25-8-09	09-9-09

For physiochemical analyses, water samples were collected in 1 litre polyetehylene (PET) bottles. For bacteriological analyses, sterilized PET bottles of 0.5 litre capacity were used. For sampling from water distribution system, only such taps were selected which were un-rusted, supplying water from the service pipe, directly connected to water main and not to storage tank or reservoir. Also, the taps which were leaking between the spindle and gland were not selected due to outside contamination. Before sampling, taps were fully opened to let water waste for 2 to 3 minutes to get truly representative samples of source and distribution system.

3. Results and Discussion

3.1 Turbidity

Mean values of the test results of turbidity at all sampling points before and after monsoon are shown in Fig. 2. It was found that the test results of source samples ranged between 0.2 to 10 NTU. Upon comparing with WHO standards *(5NTU)*, all the source samples, except New Satellite Town source (W3), were satisfactory before and after monsoon. Test results of house connections ranged between 0.15 to 10.2 NTU. All the samples, except W3 house connections (W3HC1 and W3HC2), were satisfactory before and after monsoon when compared with WHO guidelines. A slight increase in turbidity was observed after monsoon. Furthermore, WHO prescribe a limit of 0.1 NTU at source for effective disinfection of water. It can be observed that the water obtained from tube well satisfied this limit while water at W1, W2 and W3 did not satisfy this limit and thus effective disinfection cannot be done at these water sources. This clearly showed that the process of treatment involving sedimentation and slow sand filtration had a poor performance and must be improved to get lower values of turbidity.

3.2 pH

Mean pH values for all the sampling points before and after monsoon are shown in Fig.3. pH for the source samples ranged between 7.1 to 7.5 before and after the monsoon. All sources were satisfactory as they fell within the WHO guidelines i.e., 6.5-8. The pH of water at all the house connections was also satisfactory before and after the monsoon as it lied in the range of 7.1 to 7.6 which is within the WHO Guidelines for pH.

3.3 Hardness

Mean values of Hardness for all sampling points before and after the monsoon is shown in Fig. 4. It can be observed that hardness of source samples range between 88.2 to 190 mg/L as $CaCO_3$, which is less than the WHO guidelines value i.e., 500 mg/L as $CaCO_3$. So all sources were satisfactory. An increase in hardness for all sources and house connections was observed after monsoon. A separate study is needed to investigate into the reasons of this increase.

3.4 Total Dissolved Solids (TDS)

As far as TDS is concerned, all the source samples were satisfactory as the test results ranged between 107 and 151.8 mg/L which is less than the WHO permissible limits i.e., 1000 mg/L. For house connections, all samples were satisfactory as TDS lied between 109.5 and 172.3 mg/L which is well within the WHO limits. Mean TDS values for all sampling locations have been shown in Fig. 5.

3.5 Total Coliform (TC)

Mean TC values at all the sampling locations are plotted in Fig. 6. It can be seen from Fig. 6 that no TC contamination was present at the tube well (T) with a TC count of 0 MPN/100 mL while all the other sources and house connections were contaminated with a TC count of higher than 0 MPN/100 mL. Also, contamination at all sources, except (T) slightly increased after monsoon.

For house connections, TC ranged between 190 to 710 MPN/100mL before and after the monsoon, which is above the permissible WHO guidelines. Also, contamination slightly increased after monsoon. A separate study is suggested to investigate the reasons of increasing TC contamination after monsoom.

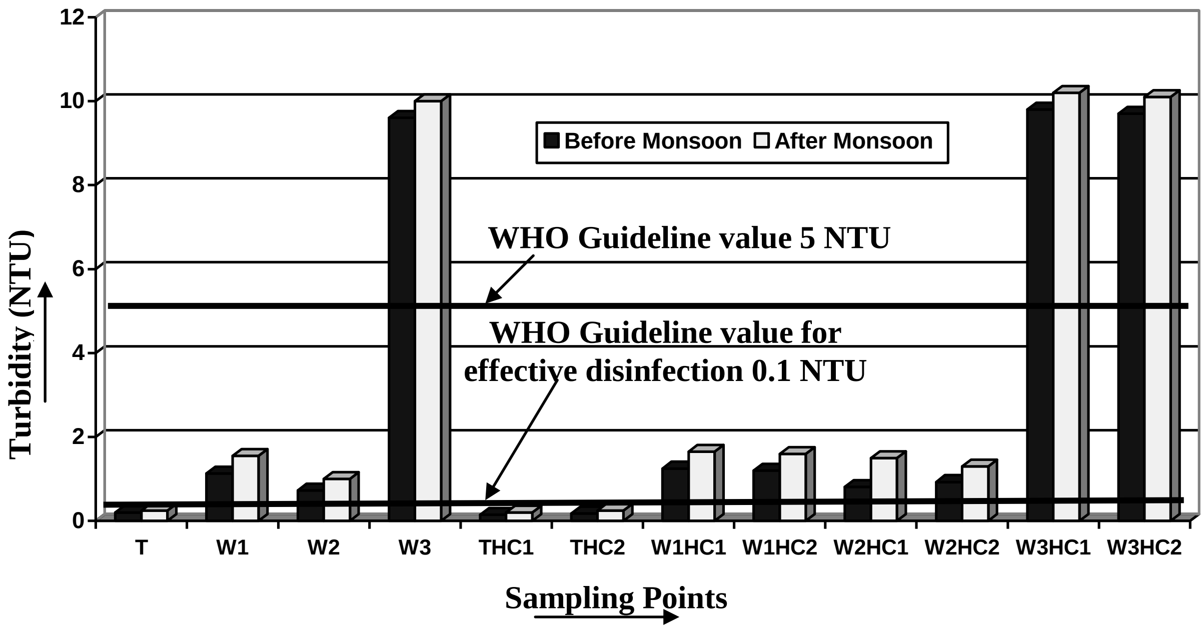

Fig. 2: Mean values of turbidity at various sampling points before and after monsoon

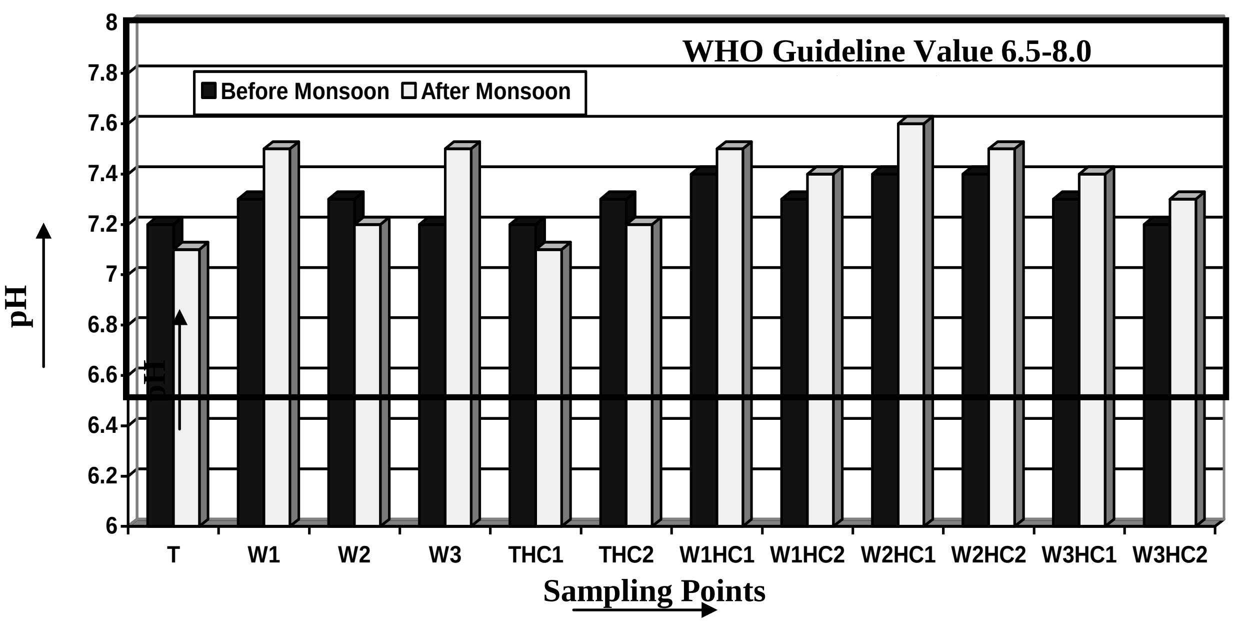

Fig. 3: Mean values of pH at various sampling points before and after monsoon.

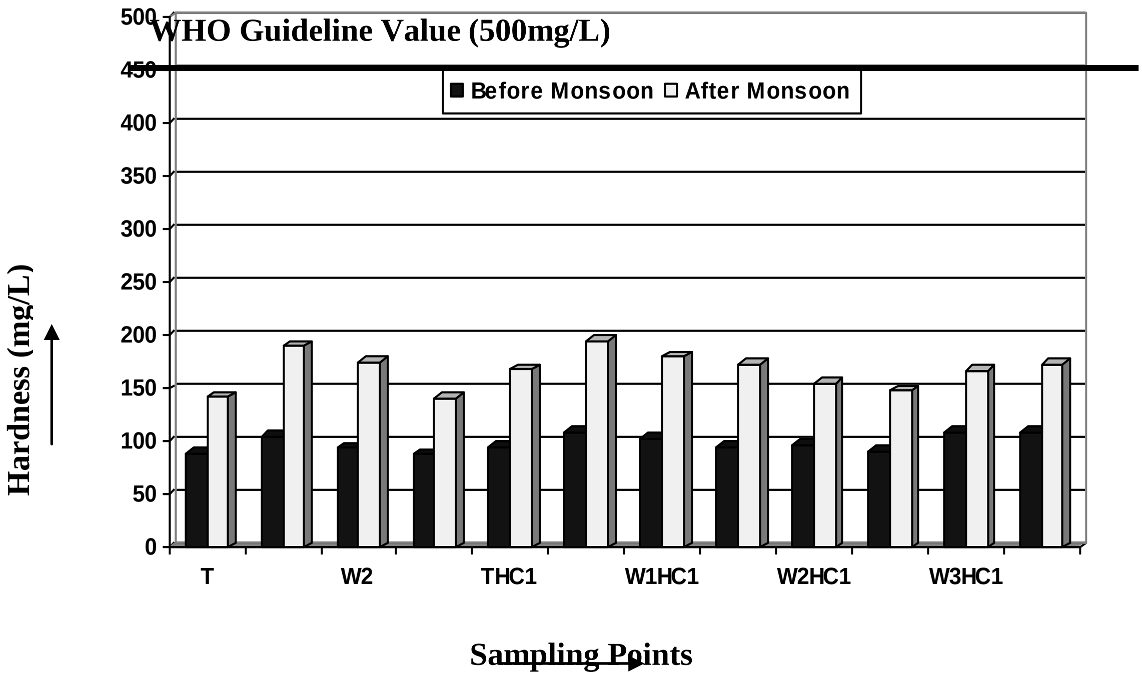

Fig. 4: Mean values of hardness at various sampling points before and after monsoon

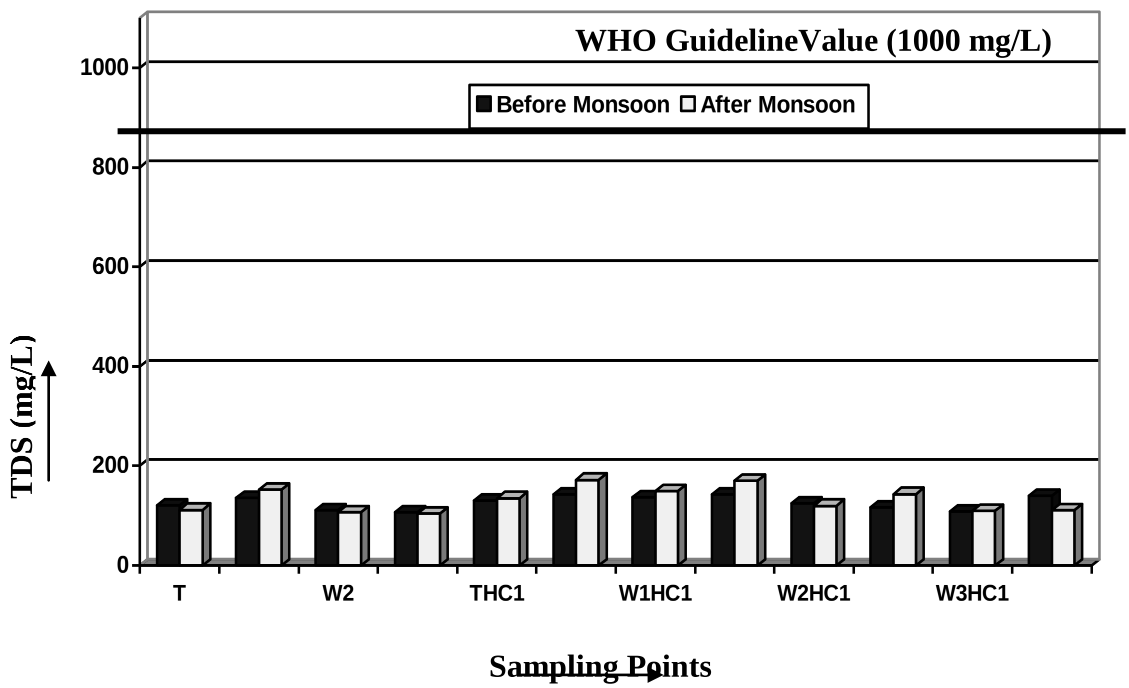

Fig. 5: Mean values of total dissolved solids (TDS) at various sampling points before and after monsoon

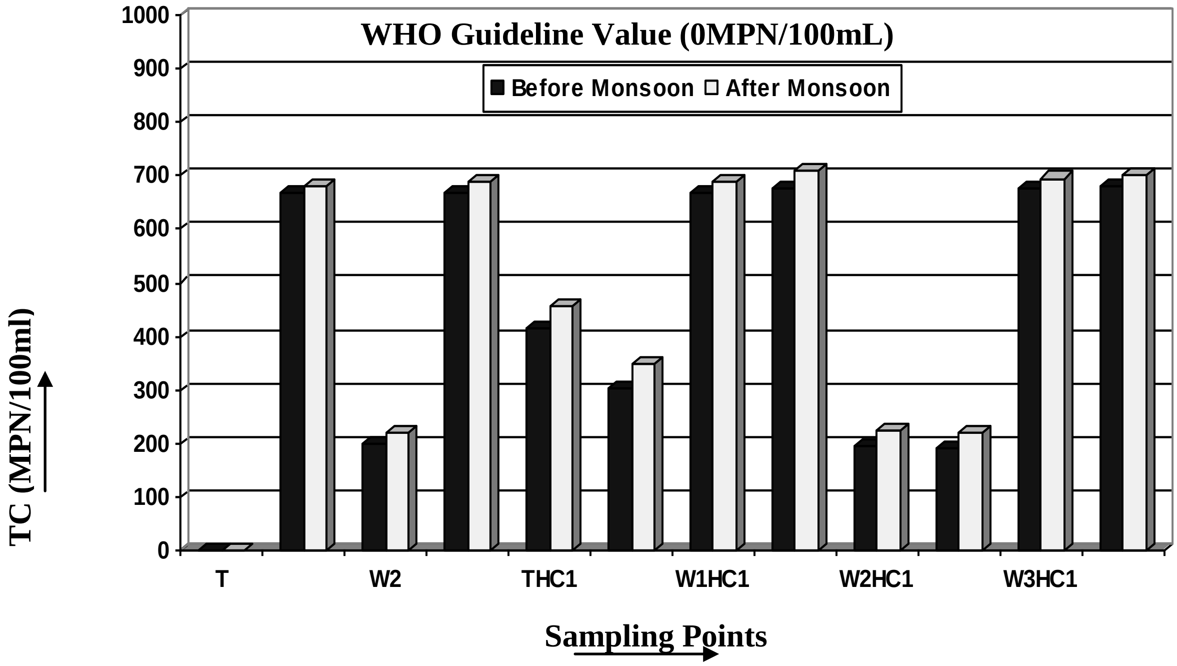

Fig. 6: Mean values of Total Coliform (TC) at various sampling points before and after monsoon

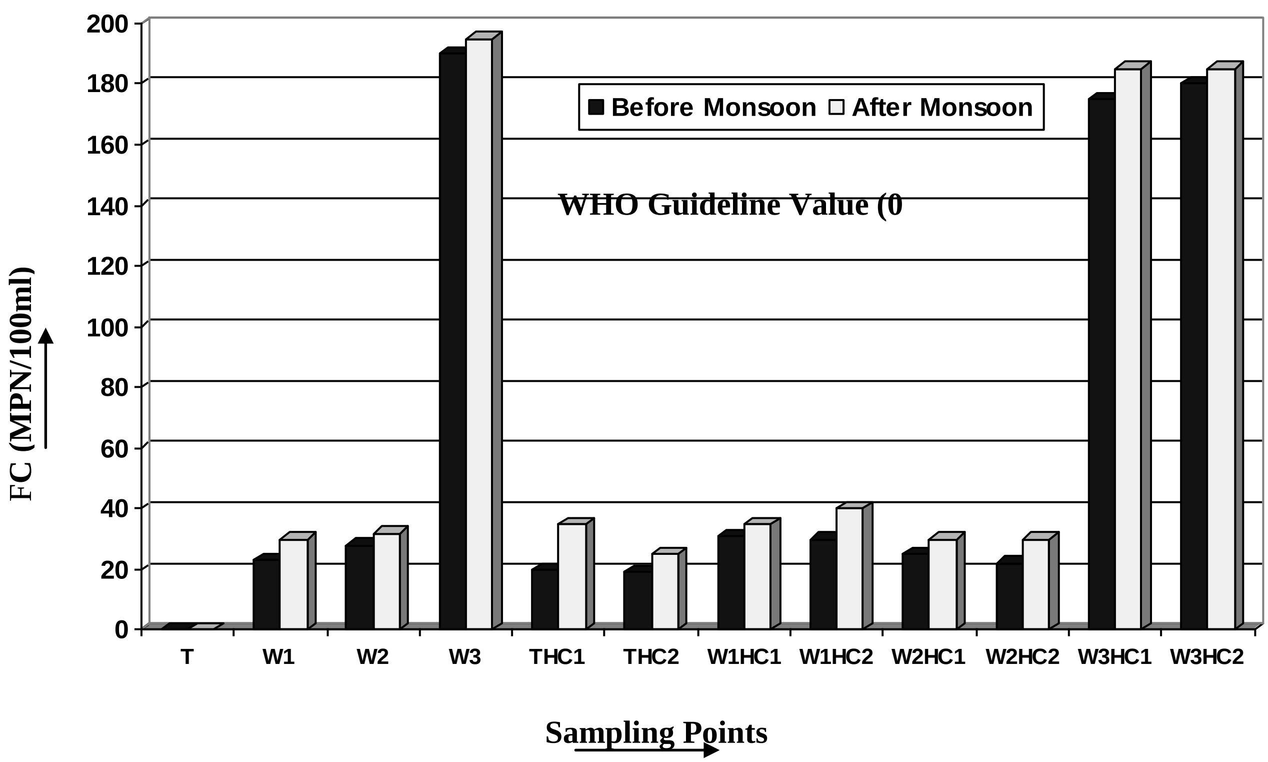

Fig. 7: Mean Values of Faecal Coliform at Various Sampling Points Before and after Monsoon

3.6 Faecal Coliform (FC)

Mean results for FC at all sampling locations are plotted in Fig. 7. For source samples, values ranged between 0 to 195 MPN/100ml. All sources, except the tube well source (T), were faecally contaminated. The contamination slightly increased at all sources, except the tube well source, after monsoon.

The FC count for house connections ranged between 19 and 185 MPN/100mL, which shows that water at all HCs was faecally contaminated. Also, all samples showed a slight increase in contamination after monsoon. A separate study is recommended to investigate into the reasons of increasing FC contamination after monsoon.

The microbiological contamination at sources based on raw canal water may be due to: (1) inadequate treatment and (2) lack of disinfection before the supply to the consumers. The contamination at house connection of tube well may be due to cross connection between the leaking distribution pipes and nearby sewers.

4. Conclusions and Recommendations

1. Physiochemical quality of all the sources, except W3, was satisfactory. However, bacteriogically, except the tube well source, all sources were contaminated. The contamination rose after monsoon.

2. Bacteriological contamination was may be due to inadequate treatment and no disinfection at the water works. Other reason of bacteriological contamination in distribution system may be intermittent water supply, poor maintenance, improper layout of water and sewer lines and poor sewerage and drainage system in the area.

3. Physiochemically, the quality of water at all the house connections, except, W3HC1 and W3HC2, was satisfactory. Bacteriologically, all samples were contaminated. The contamination increased after monsoon.

4. It is recommended that in future water supply and sewer pipes be laid on opposite side of streets to avoid cross connection between them.

5. Public be made aware of the importance of public health issues related to water and sanitation.

5. Acknowledgements

This study was funded by head grant 22000 of University of Engineering and Technology, Lahore, Pakistan. The assistance of Mr. Muhammad Hashmat in laboratory work is acknowledged,

6 References

[1] Carr.G.M.,Neary.,J.,P.,(2008), "Water Quality for Ecosystem and Human Health", UNEP, Ed. 2nd,4-8,34.
www.unwater.org/worldwaterday/.../water_quality_human_health.pdf- (Tues, Aug 03, 2010)

[2] Steel., W., E., (1992), " Water Supply and Sewerage", Mc-Graw Hill Book Company, New York, USA, Edition 6th , 2-5, 204

[3] National Health and Medical Research Council, Agriculture and Resource Management Council of Australia and New Zealand, (1996), "Australian Drinking Water Guidelines", Chapter 2, 1-18.

www.nhmrc.gov.au/_files_nhmrc/file/publications/.../eh19.pdf (Sat, May 15, 2010)

[4] Aziz., J., A.,(2005), "Management of Source and Drinking-Water Quality in Pakistan,Eastern Mediterranean Health Journal,11,1087-1098.

[5] "Pakistan's Waters at Risk",(2007), A Special Report, Freshwater and Toxics Program, WWF Pakistan, 1-2

www.wwfpak.org/pdf/water-report.pdf - (Mon, April 13, 2009)

[6] *Draft South Asia (DSA), Water Vision 2025, (2000), Country Report, "Pakistan, Maharashtra, India, Global Water Partnership", South Asia Technical Advisory Committee Regional Office.*

[7] *Working Paper, "Rationale of National Drinking Water Policy",(2005), 3.* environment.gov.pk/.../Formulation of Drinking water policy.pdf (Thurs, May 28, 2009)

[8] *EXPRESS News Channel, Pakistan, Television News report, (April 26, 2009), "QualitySS of Drinking Water of Sargodha City".*

[9] EXPRESS News, Pakistan, News paper report, edition dated (Dec 07, 2008), "Quality of Drinking Water in the Schools of Sargodha City".

[10] "WHO Guidelines for Drinking Water Quality", (2004), Vol 1, Edition 3rd. www.lifesourcewater.com/pdfs/WHO -Guidelines 3rd Edition.pdf (Thurs, May 28, 2009)

[11] World Health Organization, Geneva, (1996), "Guidelines for drinking-water quality, Health criteria and Other supporting information", 2nd Ed., Vol. 2. https://www.who.int/entity/water_sanitation_health/.../2edvol2p1.pdf - (Wed, May 19, 2010)

[12] WHO, (2004), IWA Publishing, "Safe Piped Water: Managing Microbial Water. Quality in Piped Distribution Systems",1-15. 200.10.250.206/bvsacg/e/cd-cagua/guias/c.../01.safepipedwater.pdf (Sat, May 15, 2010)

[13] Standard Methods for The Examination of Water and Wastewater (1998), APHA, AWWA, WEF, USA

[14] World Bank, Government of Punjab, Status Quo Report Sargodha, (Dec 2006), "Urban Water Supply and Sewerage Reform Strategy: www.urbanunit.gov.pk/downloads/rtWSSSargodha.pdf - (Tues, May 04, 2010)