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WATER, SANITATION AND HYGIENE: CHALLENGES OF THE MILLENNIUM

Faecal contamination in water before and after intervention

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MICROBIAL CONTAMINATION IS the most critical risk factor in drinking water quality with high potential of causing water born diseases. Illness derived from chemical contamination of drinking water supply system is negligible as compared to the number due to microbial pathogens (Galbraith et al.,1987; Herwaldt et al, 1992). However it is appreciated that in some cases (such as the Arsenic situation in Bangladesh.) with chemical contaminant a major crises can develop. The World Health Organization (WHO), has estimated that up to 80 percent of all sickness and diseases and 30 percent of deaths in the developing world is caused by inadequate sanitation, polluted water, or unavailability of water and poor hygiene. A recent survey carried out in developing countries shows that 1.2 billion people suffer form diseases caused by unsafe drinking water or poor sanitation, more than four million children die from waterborne diseases and fifteen percent of children will die before reaching the age of five to diarrhoea-deaths that might be avoided with reasonable water and sanitation services (Juha I Uitoo et al,1999). Similarly, in Pakistan 60 per of child mortality is attributed to water born diseases (Editorial, Daily Dawn, Nov.19, 1999).

Northern Pakistan including Chtiral, consists of 1.3 million population. Glaciers and snow deposits are the principal sources of all waters in northern Pakistan. The melted water enters streams called nallahs, which subsequently feed man-made channels that bring water into the settlements for agriculture, livestock and domestic use. Almost every village in the Northern Areas and Chitral has a network of water channels. Generally, a main channel carries water into the village, which subsequently divides into a network of smaller channels and water courses covering the entire village. Traditionally water for domestic use is fetched from nearest possible source i.e. stream, spring, channel or river. A common practice in the area is the use of water-pits, locally called as *Gulko, Sardawai and Chudong*. Piped water supply systems (fed by gravity) are now beginning to replace the traditional systems with a gravity fed water supply system. A water quality survey reports shows that 95 % of the traditional drinking water sources including water channels, shallow water pits, storage vessels and as well as pipe water were found to be grossly (>100 E.coli /100 mL) contaminated with faecal material (Raza. et al, 1998).

Keeping in view the research phase findings and the alarming number of water borne diseases, WASEP initiated its intervention programme in mid 1997 aiming at improving the quality of life in northern Pakistan by providing safe drinking water, appropriate sanitation facilities, health and hygiene education as well as drainage system. WASEP intends to implement its integrated approach of interventions in 105 villages in northern Pakistan. WASEP has already completed its interventions in more than 40 communities and work is in progress in 30 villages at the moment. To meet the overall goal of the programme, WASEP has great interest in bacteriological and as well as chemical quality of the water. WASEP provides water having bacteriological count in the range of 1-10 E.coli/ 100 mL as set by WHO as a guideline for developing countries In order to make sure that safer water is available at tapstands WASEP has developed a unique and reliable water quality surveillance system. The main objectives of water quality monitoring programme are:

- To investigate a safer source for the water supply system
- To monitor the bacteriological quality of water at different points of the system after intervention
- To check the density of contamination at household storage containers
- To create awareness in the target population on the importance of the water quality

This paper describes the salient features of the system and will present results of the bacteriological water quality before and after the WASEP's interventions as well as the lessons learnt in the process.

METHODOLOGY

The water quality monitoring programme of WASEP has two main phases. In phase one the water quality surveys are done before the intervention of the programme components. In the second phase water quality of given systems are checked for bacterial contamination after commissioning of systems. In both phases of the monitoring system, water samples are collected from different points of water delivery systems, including storage vessels and reservoirs as well as from the source. The description of each sampling technique is given below:

a) SAMPLING STRATEGY

• *Water delivery system*

The service levels are tested pre and post interventions. Pre-intervention water quality survey of the existing systems (traditional and improved) is done once to establish the water quality situation of the village. The water quality analysis of the selected sources for the proposed water supply systems is also carried out during this survey. The post water quality monitoring of the system is done continuously for six months after commissioning of the system and then after quarterly for one year. Water samples are collected from the inlet, taps and storage vessels. The results obtained through monitoring are closely examined and remedial actions are taken accordingly.

• *Household level*

One of the major activities in the water quality monitoring programme is the analysis of household storage vessels. Water samples from household storage containers are taken before and after the intervention. In 1998, household water quality surveys, water samples were collected from each household, i.e. 100 percent coverage. However in the second year when the number of villages increased a statistical analysis showed that 20 to 30 percent would provide a significant result (Ahmad and Raza, 1999). Water samples from household storage containers are taken twice a year i.e. one before the intervention and then after the commissioning of the system. The reason for looking the water quality in the storage container is to look at any change in the bacteriological quality of drinking water at the point of ingestion since it is the final source from which individuals normally drink from.

• *Sampling technique*

WASEP uses 7 Del-Agua water testing kits. The basic technique used in these kits is the membrane filtration technique in which water samples are passed through a membrane filter of 0.45um pore size and 0.47 mm diameter by creating a vacuum. The membrane is then placed on a pad saturated with selective a medium for thermo tolerant E.coli (membrane Lauryl Sulphate Broth) and is incubated for 18 hours at 44°C. After 18 hours of incubation the yellow color colonies are enumerated and reported per 100 mL(OXFAM Del Agua, 1993).

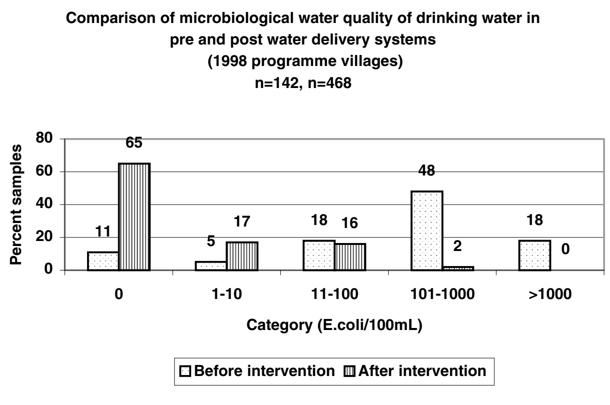

Figure 1

RESULTS

• *Water delivery system:*

The results of pre-water quality analysis of the existing water delivery systems and sources collected from 15 villages of the year 1998 revealed that only 16 percent of the 142 water samples matched with the WHO guideline values for developing countries i.e. 84 percent water samples were found to be grossly polluted with faecal material and falls in the categories of high to very high health risk However, the post-intervention water quality monitoring results showed significant improvement in the bacteriological water quality in the system (see Figure-1). Out of 468 water samples collected from various representative points in the distribution network, 82% were in category-1 (0-10 E.coli/ 100 mL) of the WHO standards for developing countries i.e. no health risk.. It is worth mentioning that at tap stand level WASEP achieved its target already set in the Logical Frame Analysis (LFA), which states that at least 75% of the total tap stands samples will meet the WHO guideline (0-10 E.coli/100 mL) for developing countries.

In one WASEP programme village (Hasis) four months of post-intervention water quality monitoring results showed that 90% of the samples collected from different location of the system did not comply with the WHO guideline values (0-10 E.coli/100 mL), hence the source of the system was changed from nallah to spring. Now 100% of the water samples collected from delivery system show zero E.coli/100 mL Initially during feasibility stage the nallah had a low bacterial count (< 10 E.coli/100 mL) but when the scheme was commissioned the source characteristic changed with the last summer floods.

• *Household level*

1052 water samples were collected from household storage containers from 15 villages during the pre-intervention water quality survey. The results revealed that before water, sanitation and health and hygiene interventions the density of contamination levels in household containers were very high. Out of 1052 water samples only 26 percent of the total samples matched with WHO criteria for drinking water for developing countries whilst 74 percent of the total samples were highly contaminated with faecal material.

The contamination levels in post-intervention samples were significantly reduced towards lower categories (see Figure-2). Out of 418 household storage water samples (collected randomly), 74 percent of the samples have contamination levels in the range of 0-10 E.coli/100 mL. However, 26 percent of the total samples still were in the categories of high to very high health risk. Reasons for this contamination might be poor water handling practices or unhygienic situations of the storage containers or surrounding environment. Secondly 18 percent of the systems samples had contamination levels in the range of >10 E.coli/100 mL and 35 percent had the contamination levels > 1E.coli / 100 mL. The number of E.coli might have increased during the storage time.

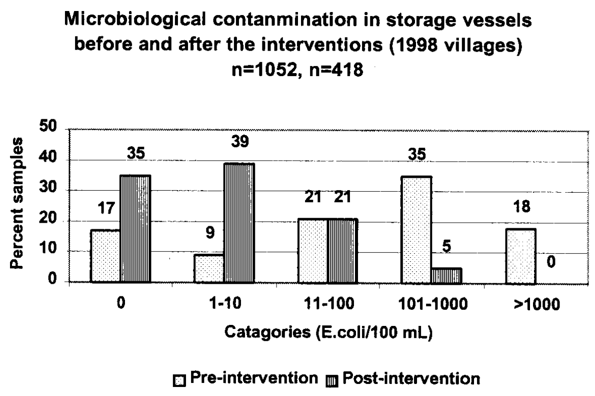

Figure 2

Discussions:

The post implementation water quality monitoring results reveal that in all of WASEP's programme villages the bacteriological water quality is safer when compared to the systems used for drinking purposes previously. Majority of the pre-intervention samples falls in the categories of very high health risk. (See Figure-1). Reasons for this high level of faecal pollution was the usage of traditional water sources (channels, shallow water pits) used for drinking purpose. A negligible number of samples (16%) were in the category of no health risk, mainly because these specific water samples were taken from the sources where the likelihood of contamination levels were very low. The post-water quality monitoring results showed a significant improvement in the bacteriological water quality in the delivery system. Majority of the samples (84%) comply with the WHO standards set for developing countries whilst 16 % samples have the contamination levels in the range of 10-50 E.coli/ 100 mL. Keeping in view the monitoring results the intake of those water supply systems showing E.coli levels above the WASEP defined limits now have been changed. It would be worth to mention that at tap stand level WASEP meets the target set in its LFA, which states that at least 75% of the total tap stands samples will meet the WHO guideline (0-10 E.coli/100 mL) for developing countries.

The water samples collected from household storage vessels before and after the intervention also shows significant improvement in the bacteriological water quality at the point of ingestion as compared to the results of the water samples collected before intervention. The main reason for high bacterial count in pre intervention household water samples was their water collecting points that were already highly contaminated with the faecal material. However, the contamination levels in post-intervention samples were significantly reduced towards lower categories (see Figure-2). Reason for this significant reduction in the contamination levels is two fold. Firstly the quality of water at the point of collection is improved as compared to the previous water collection points (traditional sources) and secondly the frequent visits of health and hygiene promoters improve behavioral practices especially with regard to water handling and storage practices. Significant improvement has been achieved in reduction the incidence of water born diarrhoeas in the partner villages. On average a 50 percent reduction been observed in incidence of diarrhoea when compared to the baseline data acquired before the implementation of the WASEP Programmes.

Conclusions:

It is evident from the results that WASEP is providing safer water to their partner villages as compared to previous drinking water sources. WASEP, experience indicates that a water quality monitoring programme is an essential component to ensure the drinking water quality is maintained; and must be in place for the provision of safe drinking water especially where the surface water is used for supply systems and where the possibility of sudden change exists in he bacteriological contamination. The presence of an effective water quality programme is vital to take immediate and practical measures well in time to keep the quality in the defined limits of the programme.. WASEP's experience shows that water quality results can be used as an effective tool to sensitize and create awareness in the target population through health and hygiene education. One of the important finding of the monitoring system is that only provision of safe water at tap stand levels doesn't mean that users are consuming the safe water. (See Figure-2). It is worth mentioning that the contamination levels in household storage vessels directly reflects the behaviors of some of the household towards water handling practices. WASEP's health and hygiene education section is using this data to improve the existing handling practices of water. WASEP's experience proves that this type of monitoring programme can play a vital role to achieve the intended programme goals a that aim to provide safer water to the target population. One of the major achievements of WASEP's water quality mentioning programme is that now other sectors involved in the water supply systems are willing to adapt WASEP strategy and requesting to do water quality tests for them.

REFERENCES:

Galbrath, N.S., Barnelt N.J. and Stanwell-Smith R., 1987 water and disease after Croydon: A review of water associated diseases in the United Kingdom (1937-1980), Journal of the institution of water and environmental management,1,7-21

Herwaldt,B.L., et al 1992, Out breaks of water disease in the united states:1989-1990, Journal of the American water works association, 84,129-35

Raza,H. Hussain, H, Alibai,K.(1998) "Seasonal Investigation of Drinking Water Quality" 24th WEDC Conference Islamabad, Pakistan

Ahmad, T, and Raza, H. (1999), "Health Impact Assessment in Northern Areas and Chitral: Implications for WASEP", Internal Report, WASEP, AKHBP, Gilgit, Pakistan.

OXFAM DELAGUA, Users Manual, Portable water testing kit, Robens Institute & WHO; University of Surrey, Guildford GU2 5XH , United Kingdom, 1993.

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