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PEOPLE-CENTRED APPROACHES TO WATER AND ENVIRONMENTAL SANITATION

Water quality monitoring of improved water delivery systems in Northern Pakistan

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The Water And Sanitation Extension program (WASEP) of Aga Khan Planning and Building Service Pakistan has been implementing water supply projects to improve the traditional water delivery systems for drinking purposes since 1998 aiming to reduce water borne diseases. In this connection 105 water supply systems have been implemented in rural communities of its program area with the financial assistance of KfW of Germany. Improved delivery systems were monitored for bacteriological quality through a series of sampling frequency from 1998 to 2002. The water quality monitoring program was developed locally consisting two phases, pre and post intervention. During pre intervention the Bacteriological contamination level was found to be very high in existing delivery systems with an average of 16% samples matching WHO Guidelines for developing countries (0-10 E.coli/100 ml). However during post intervention the bacteriological quality of water at system level significantly improved with 86% of samples matching WHO Guidelines for developing countries. Improvements in water, sanitation and hygiene behavior contributed to diarrhoeal reduction by more than 60%.

Keywords: delivery systems, rural communities, water quality, water borne diseases, hygiene, and diarrhoea.
Water is either collected directly from these sources or conveyed to individual or communal traditional water pits for storage and subsequent use. These traditional sources are grossly contaminated as in respect of bacteriological quality of water. Generally the piped water was also found to be highly contaminated in the area ranging 48 – 372 E. coli/100ml in winter and 191-417 E. coli/100ml in summer. In summer the channel water was significantly more contaminated with the levels as high as 462 – 3025 E. coli/100ml (H.Raza et al).

According to WHO for drinking water to be safe a 100 ml sample of water should not contain any coliform bacteria (Pillai et al., 1999). According to research findings of the Water Sanitation Health and Hygiene Studies Project (WSHHSP 1993 – 1997), through seasonal water quality monitoring monthly and intensive monitoring in randomly selected and representative sample villages in Northern Pakistan, the microbiological quality of drinking water was found to be highly polluted within the range of 1500 – 5000 E. coli per 100 ml in traditional delivery systems, 50 – 500 E. coli per 100 ml in existing pipe water (Intensive and Seasonal water quality sampling by WSHHSP, 1993 – 1997).

Based on these findings, the Water and Sanitation Extension Program (WASEP) of the Aga Khan Planning and Building Service, Pakistan has been implementing water supply projects to improve the traditional water delivery systems for drinking purposes since 1998 aiming to reduce water borne diseases. 105 water supply systems have already been implemented in rural communities in its program area with the financial assistance of KfW of Germany. Most tap water is provided through gravity flow water supply systems. WASEP has developed a reputation in its program area for being a specialist in providing water treatment technologies for high turbid water. The engineering and environmental team has done extensive research on appropriate treatment methods. WASEP has chosen to use sedimentation, up flow roughing filtration and slow sand filtration systems to reduce turbidity levels and microbial contamination. As a result of latrine promotion 80% of households build improved latrines. The bacteriological quality of water at system level significantly improved with 85% of samples matched with WHO guidelines for developing countries. Improvements in water, sanitation and hygiene behavior contributed to over 60% diarrhoea reduction.

Improved delivery systems were monitored for bacteriological quality through a series of sampling frequencies from 1998 to 2002 in Northern Pakistan. Experience from both developing and developed countries has shown that surveillance of community managed supplies can be effective when well designed and the objectives are geared more towards a supportive role to enhance community management and in evaluating overall water supply strategies, rather than enforcement of compliance. In the case of evaluating strategies, the principal aim should be to monitor the water quality over all seasons for improving water safety for all community managed supplies, rather than monitoring performance for individual supplies. A water quality monitoring program was developed locally consisting two phases, pre and post intervention. During pre intervention the bacteriological contamination level was found to be very high in existing delivery systems with an average of only 16% samples matching WHO guidelines for developing countries (0-10 E.coli/100 ml). Whereas during post intervention the bacteriological quality of water at system level significantly improved with 86% of samples matching WHO guidelines for developing countries which indicates satisfactory achievement the target set in the logical frame analysis (LFA) developed by WASEP, which is that 75% of the total tap stands will meet the WHO guidelines i.e. 0 – 10 E. coli/100ml for developing countries.

**Objective**

The main objectives of water quality monitoring were the following:

- To identify safer sources for water supply systems.
- To create awareness among the communities involved in the implementation of the intervention.
- To take remedial actions if any health risks were found.

**Test parameters and methodology**

The test parameter selected as indicator for faecal contamination is the faecal Coliform, Escherichia coli (E. coli) which is detected by using the portable Del-Aguaâ water kit with standard Membrane Filtration technique. Pre and Post bacteriological water quality monitoring is one of the major activity of the WASEP.

**Sampling area and collection of water samples**

The water sampling was carried out in three different regions of the program area, Gilgit, Baltistan and Chital. 3 male microbiologists and 16 female Health and Hygiene Promoters
Comparative results of pre and post intervention

Water quality monitoring activities were carried out in two phases i.e. pre intervention water quality baseline survey and post intervention water quality monitoring on system level and household level. During pre intervention samples were tested from existing delivery systems as well as from household storage containers, while during post intervention samples were tested from source, reservoirs, treatment plants and distribution points as well as from household storage containers also.

System level

A total 354 water samples were tested during pre intervention from existing delivery systems out of which only 16% samples found matching WHO guidelines (0-10E. coli/100 mL). Whereas during post intervention 2620 water samples were tested from improved water supply systems, the results show a significant improvement with 86% samples matching WHO guidelines. (see table: 1)

| Table 1. Consolidated microbiological result of pre and post Intervention of system level |
|---------------------------------------------|---------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Phase                                       | #. Samples | 0-10 | 11-100 | 101-1000 | >1000 | WHO standard* matched |
| Pre Intervention                            | 354        | 16   | 31     | 35       | 18    | 16%              |
| Post Intervention                           | 2620       | 85   | 12     | 3        | 0     | 85%              |

Results of post intervention show that a considerable variation in contamination occurred in project villages with nulla (watercourse) and spring sources. Nulla water is mainly glacial water, which becomes contaminated by animals and humans, thus it may vary with each sample depending on human or animal activities. Therefore, the contamination of such sources sometimes exceeds the recommended guidelines and is sometimes below recommended guidelines. According to the data of water quality monitoring, 76 projects with spring sources out of 100 were found to be 100% free of bacteria. However only two project villages with spring sources Ashrait and Balim in Chitral were found to be contaminated with faecal coliform. This was because of seepage of surface water from the surroundings of these spring sources. Remedial action was taken to improve of these sources. In the remaining 25 project villages the quality of water found was found to exceed WHO recommended guidelines where almost sources are nulla (stream) water. Taking remedial action in Hasis, a project village of 1998, the nulla source has been replaced by a spring source with extension of feeding pipe line to the supply system which resulted in the reduc-
tion of microbiological contamination to zero. For remaining projects further remedial actions could not taken due to lack of funds and an end of the program phase.

Water and Environmental Sanitation (WES), UNICEF Pakistan provided for and introduced the use of the H2S paper strip test for detection of fecal contamination of drinking water in Northern Pakistan. Water and Sanitation Operators found these easy to use to monitor water supply systems.

**Household Level**

During pre-intervention a total 1462 samples were tested from household storage containers. The over all result of post intervention shows a significant improvement, namely out of 728 samples, 63% samples result matched with WHO guidelines (see table: 2)

<table>
<thead>
<tr>
<th>Phase #. Samples</th>
<th>0-10</th>
<th>11-100</th>
<th>101-1000</th>
<th>&gt;1000</th>
<th>WHO standard matched</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre Interven. 1462</td>
<td>16</td>
<td>28</td>
<td>37</td>
<td>18</td>
<td>16%</td>
</tr>
<tr>
<td>Post Interven. 728</td>
<td>63</td>
<td>21</td>
<td>16</td>
<td>1</td>
<td>63%</td>
</tr>
</tbody>
</table>

It is necessary to mention here that 80% of villages were covered for household level sampling during the baseline survey pre intervention whereas only 40% villages were covered during post intervention water quality monitoring. 60% of villages did not store water in containers as they have quick access to tap in yards or kitchens. According to the comments made by the community women, because they have become aware of germs, they think that stored water might be contaminated therefore they preferred to fetch water directly from taps instead of storing it in containers. This indicates behavioral changes in water handling practices by awareness rising through hygiene education.

**Conclusion and recommendations**

It can be concluded through the findings of water quality monitoring and health impact study, that water borne diseases can be reduced through providing safe drinking water, appropriate sanitation and the changing of behavior through health and hygiene education. The risk of water pollution can be removed through providing safe drinking water. For community managed water supply systems, to ensure water safety, regular monitoring should be carried out through random visits by system operators using simple techniques like the H2S paper strip test (a product of Water Health Laboratories, Rorki India for bacteriological test). A proper surveillance system at regional level should be developed to make it sustainable and useful by taking remedial actions on the basis of sanitary observation and water quality reports. To ensure improvements where needed on the basis of water quality monitoring and sanitary observation, a special budget should be established by the responsible authorities. To ensure providing safe water through the existing piped systems in the area, water quality monitoring should be carried out to make it possible to take remedial action for improvement on the basis of sanitary and microbiological results.

A leading research study (Evaluation of a water, sanitation, health and hygiene education intervention on diarrhoea in northern Pakistan) published in the WHO March 2003 bulletin, concludes that the integrated approach taken by appropriate health and hygiene education and water quality monitoring is a useful example of how desired health benefits can be obtained.

**References**


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