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Analysis of community led total sanitation and its impacts on groundwater and health hygiene

Ihsan Ullah Khan[1,2], Shams Ali Baig[3]*, Bahadar Nawab[4], Tahir Mahmood[4] and Ingrid Nyborg[5]

[1]Department of WASH and Humanitarian Assistance, Norwegian Church Aid (NCA), Islamabad, Pakistan.
[2]Department of Environmental Sciences, COMSATS Institute of Information Technology (CIIT), Abbottabad 22060, Pakistan.
[3]Department of Environmental Sciences, Abdul Wali Khan University, Mardan 23200, Pakistan.
[4]Department of Development Studies, COMSATS Institute of Information Technology (CIIT), Abbottabad 22060, Pakistan.
[5]Department of International Environment and Development Studies, Norwegainn University of Life Sciences (NMBU), Norway.

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This study was carried out to determine the magnitude to which Community Led Total Sanitation (CLTS) approach leads to improved sanitation and its potential threats to groundwater quality and health of people. A comparative study was carried out between eight CLTS and non CLTS villages to measure the outcomes of CLTS approach. Water samples were collected to assess the level of contamination in groundwater sources near pits in villages where CLTS approach was adopted. Semi structured interviews, focused group discussions (FGDs) and transit walks were used for data collection. Results revealed the tendency of high level of groundwater contamination in CLTS as compared to non CLTS villages which might be because of pit latrines in the area. Water for hand washing is available, but the use of soap depends upon the economic status of the households. However, 5% increase in the hand washing practices was noticed during the field data collected in CLTS implemented village as compared to non CLTS villages. In addition, water borne disease prevalence was also noticed in CLTS villages, but some improvements were observed in terms of hygiene among the people in CLTS implemented villages. The findings showed that the drinking water quality is deteriorated in the study areas which could be linked to promotion of sanitation systems that do not break the pathogen cycle.

Key words: Community Led Total Sanitation (CLTS) villages, groundwater contamination, Environmental sanitation, health, hygiene.

INTRODUCTION

Access to improved sanitation and safe drinking water is serious issue in many developing countries including Pakistan. Globally, 2.5 billion people lack access to improved sanitation while 748 million people lack access to improved drinking-water. It is estimated that 1.8 billion people use a source of drinking-water that is feacally contaminated. Worldwide, 1 billion people practice open defecation (UNICEF, 2014). The Joint Monitoring Program (JMP) developed a strategy for the progress in sustainable access to safe water and basic sanitation by

2025, but many countries are not on the track to achieve the targets (WHO, 2010). Community Led Total Sanitation (CLTS) is widely recognized as an innovative participatory approach to rural sanitation (Kar, 2005) with aim of open defecation free (ODF) communities by promoting community examination and action (Kumar and Shukla, 2008).

Bacterial pathogens cause some of the most feared infectious diseases, such as cholera, typhoid and dysentery, which are quite common in Pakistan. Inadequate sanitation is estimated to cost Pakistan 3.94% of GDP. In Pakistan, only 9 out of 10 have access to water and more than 3 out of 10 do not have access to sanitation (Howard et al., 2001). However, the latest studies showed that hand washing with soap can play an important role in eradication of pneumonia to a greater extent (Curtis and Cairncross, 2003). In Indonesia, the CLTS has created the opportunity for communities to take better control over their sanitation and health outcome (Mukherjee and Shatifan, 2008). CLTS helps in eradication of the health incidences.

In Pakistan, over 15 million people have no choice but to collect dirty water from unsafe sources and over 93 million people do not have access to adequate sanitation in Pakistan, over half of the population (Water Aid, 2015). Inadequate water supply, sanitation and hygiene have led to higher rate of water borne diseases which in turn increase the mortality and morbidity rates in Pakistan. Diseases related to water, sanitation and hygiene (WASH) account for 110 deaths of children under-5 every day in the country. Lack of sanitation facilities in schools is deterring children, particularly girls, from enrolling and staying in school. Girls' menstrual hygiene needs are rarely accommodated in schools, serving as a further deterrent (UNICEF, 2014).

To explain variations in water quality, one would have to take into consideration hydrogeology, topography, soil condition and underground water levels. The distance between the source of contamination and the point of abstraction affects the removal and elimination of bacteria (Cave and Kolsky, 1999). The use of poorly constructed sewage treatment works and land application of sewage can lead to groundwater contamination close to water supply sources (Pedley and Howard, 1997). For this reason, not only coliform including *Escherichia coli* can be detected, but estimation must also be made of their numbers in order to assess the degree of pollution and hence the danger to health (Pant, 2004; Mehta, 2009; WSP, 2008) as found elsewhere, high contamination in drinking water in the CLTS villages

CLTS is a very effective and innovative social communication process, which creates the right social pressure to ban open defecation totally and to adopt hygienic behavior (Halder, 2005). CLTS approach has widely been used in South Asia and African countries, but there are limitations in this approach that varies from country to country. In order to highlight the gaps, there is a need of explicit research with reference to each country. In Pakistan, there is a parallel approach which is Pakistan Approach to Total Sanitation (PATS), but still there are gaps which needed to be addressed. In CLTS approach, people make pit latrines which are not lined with proper sealing material and people use those latrines where they use water for anal cleaning. There is no research conducted on the potential impact of pits on ground water sources in Pakistan. Although, behavior change is the ultimate goal of CLTS, but the impact of health and hygiene needs to be find out in CLTS villages. The objective of this study was to know the impact of CLTS-based sanitation interventions on the ground water sources, hygiene and health of community. This research is expected to provide new insights for the improvements in the CLTS process in developing countries.

RESEARCH METHODOLOGY

The study area was carried out in district Mardan in the Khyber Pukhtunkhwa, Pakistan. The district lies from 34° 05' to 34° 32' north latitudes and 71" 48' to 72° 25' east longitudes. The total area of the district is 1632 km^2. Generally, stream flows from north to the south. Most of the streams drain into Kabul River. Kalpani, an important stream of the district rises in the Baizai and flowing southward and finally joins Kabul River. The summer season is extremely hot. A steep rise of temperature observed from May to June. Even July, August and September record quite high temperatures. The temperature reaches to its maximum in the month of June, that is, 43.5°C (110.3°F). Most of the rainfall occurs in the month of July, August, December, and January (Figure 1).

Eight villages (four CLTS and four non CLTS) were purposely selected (Table 1). In each village, 10 households and 10 key persons, religious leaders and local health practitioners were purposely selected for interview. The total number of households in all villages was 344, whereas semi structured interviews were conducted with head of house of 182 households. This sample was calculated with 95% and with 5 confidence interval level. The data was also collected through transit walk and personal observations. The transit walk helped to identify the hygienic conditions and open defecation practices around the village. The data was later on analyzed through simple excel sheet by categorizing various observations regarding hygiene and hand washing.

A total of 114 samples were collected from 38 underground drinking water sources from the selected villages. The distance between pit/septic tank and water sources was measured and water samples were collected to know the level of contamination from every source. Three water samples were collected from each source in order to get the more accurate results. Rotory pumps (bores), hand pumps and dug wells are the sources from samples collected for determination of contamination. The samples were

*Corresponding author. E-mail: shamsalibaig@yahoo.com. Tel: +92.937.343369.

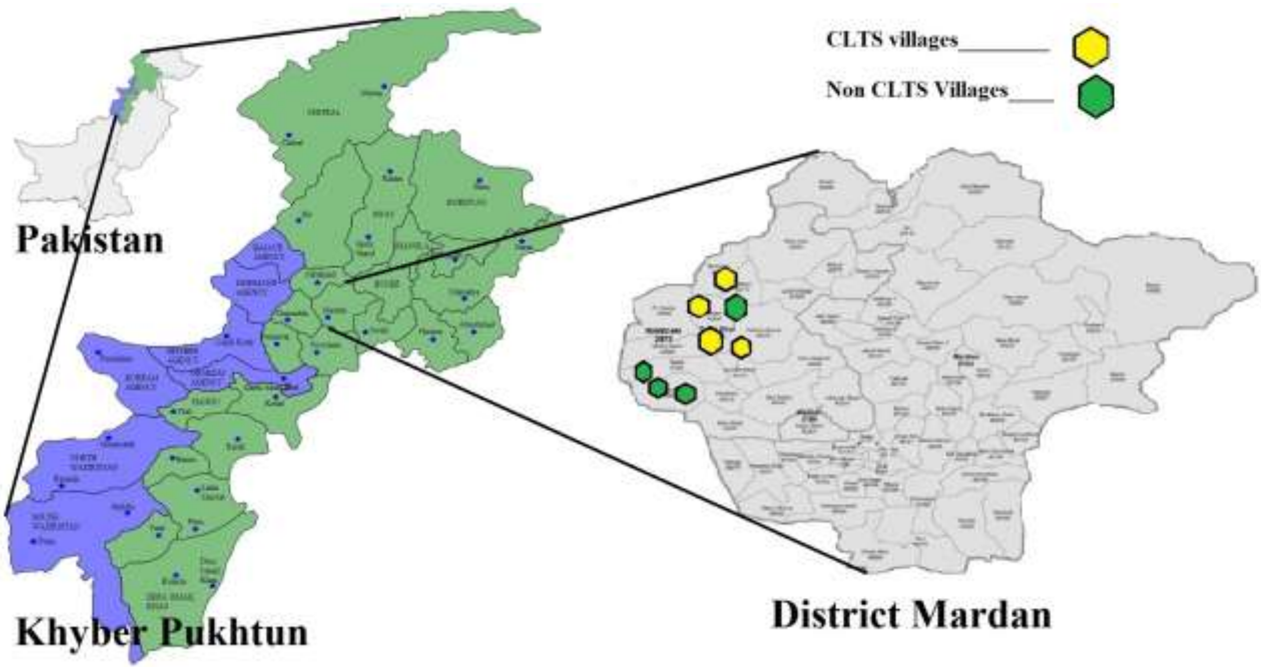

Figure 1. Map of the study area and the targeted CLTS and non-CLTS villages.

Table 1. CLTS and non CLTS villages in the study area.

S/N	Tehsil	Union council	Village name	Type of village
1	Takht Bhai	Seri Behlol	Inzar Killi	CLTS
2	Takht Bhai	Jalala	Yaqoob Banda	CLTS
3	Mardan	Chamtar	Saidazim Killi	CLTS
4	Takht Bhai	Jamal Garhi	Srekh Banda	CLTS
5	Takht Bhai	Jamal Garhi	Jangraiz killi	Non CLTS
6	Mardan	Chamtar	Miangul Zara	Non CLTS
7	Mardan	Chamtar	Serai	Non CLTS
8	Mardan	Chamtar	Chamtar	Non CLTS

preserved in ice packed cooling box and the samples were taken to the laboratory for 3 h. During travel time, the sample temperature was kept below 10°C. The membrane filter method was used for the measurement of coliform organisms and *E. coli*. The samples were inoculated using membrane luryl sulphate broth media. The samples were then incubated in the incubator for 18 h at 44°C. After 18 h, the results were noted down by counting the number of colonies (blue color) under the colony counter. 182 semi structured interviews held with the community on health and hygiene.

RESULTS AND DISCUSSION

Drinking water availability is an important component in the development of a rural community. CLTS approach aims at ending the open defecation through behavior change. The average distance between the water source and the pit in the CLTS village was measured and was found to be 10 feet on the average. In the past people use to make bathing areas and latrines near the wells to fetch water easily for bathing and ablution. Currently, some of the households have constructed pour flush latrines who could afford the costs. A shift in use and construction of latrines was found in the community.

The contamination can be linked with the seepage of the waste water from the pit/septic tank towards the source. Most of the pits were built near the water sources for the easy access to water for anal cleaning. Most of the dug wells were not properly protected. The literature shows if groundwater is free of any microbial contamination, but may become rapidly contaminated if protective measures at the point of abstraction are not implemented and well maintained (Schmoll et al., 2006; Nawab and Esser, 2005). The water samples were analyzed in the laboratory and the results showed

Figure 2. Percentage of *E. coli* present in each CLTS and non CLTS villages.

variations in the amount of *E. coli*. In Yaqoob Banda which is a CLTS village shows high rate of contamination as shown in Figure 2. Similarly, Said Azim Killi also showed high level of contamination and hence the water is not fit for drinking. Based on the aforementioned analysis, it can be assumed that CLTS villages shows high rate of contamination as compared to non CLTS villages.

Relationship of pit and water source contamination (CLTS Village)

The water samples taken from households which were near with dry pits showed that 87.5% water is unfit for drinking as shown in Figure 6. It can be assumed that the sources may be contaminated due to seepage from the pits into the water source. The seepage from pit is only possible if water is used for flushing and the soil is sandy, because sandy soil is more favorable for contaminant movement. According to the CLTS worker, "The water table in the area is so deep that we do not tell people to make raised pits". So, the water is almost safe from the pit contamination. It means that the contamination could be due to other reasons and pit cannot be the only reason for contamination of water sources. However, according to the reported study (UNICEF, 2014; Water Aid, 2015; Cave and Kolsky, 1999), there is growing concern about the likelihood of pit latrine effluent infiltrating into groundwater reservoirs for well water supply systems. Pit latrine contents leach downwards and down slopes for distances that vary per season and soil type (Chidavaenzi et al., 2000). Mehta (2009) and her team in India also found that in all the CLTS villages, water contamination was the highest.

Comparison of bacteriological contamination

In CLTS villages, 73% of water samples were contaminated, while in the non-CLTS villages 69% samples were found to be contaminated with *E. coli* as shown in Figure 2. There is variation in the level of contamination in which the CLTS villages showed slightly higher rate of contamination. There might be various factors of this contamination in CLTS villages which needs to be investigated further. Figure 3a shows *E. coli* colonies which were collected in CLTS villages. Although the colonies were also found in non CLTS villages (Figure 3b), but the frequency is much lower. The waterborne diseases were noticed in the villages which may be linked with the pathogens in the drinking water. As a result, the water sources are unsafe to be used for the drinking water purposes in both cases, but the occurrence is lower in non CLTS villages.

Impacts of CLTS on hygiene

Hygiene is the basic component of CLTS approach and this is achieved through behavior change. During an interview with a village Imam (religious leader) in the non-CLTS village, he says, "*In the present age, latrine is the best option for good hygiene and clean environment, because latrine is a place that gives the safe place for defecation and also hygiene is one of the important aspects in Islam".* It was observed that people know about various aspects of cleanliness, but some of the people cannot afford to buy soap because the use of soap is not the priority of the community. In CLTS people use only water for hand washing after defecation and before taking meals, but rarely use soap but this behavior is much lower in non CLTS villages. It shows that CLTS approach was good at bringing awareness about the hand hygiene in the community.

The data was collected regarding the use of type of material for anal cleaning. The data showed that 36% of the people use water for anal cleaning in pours flush latrines, while 64% people use soil for the cleaning purpose during open defecation in the field. The data

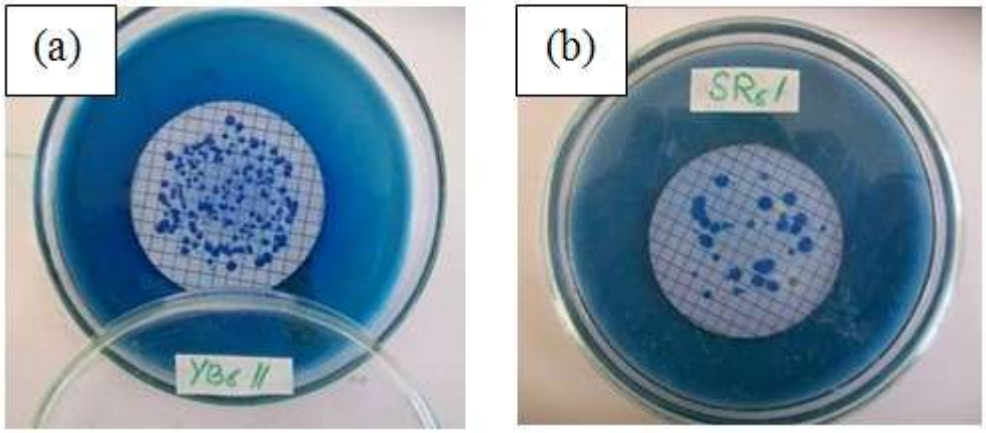

Figure 3. *E. coli* colonies of the water samples in CLTS (a) and non-CLTS (b) villages.

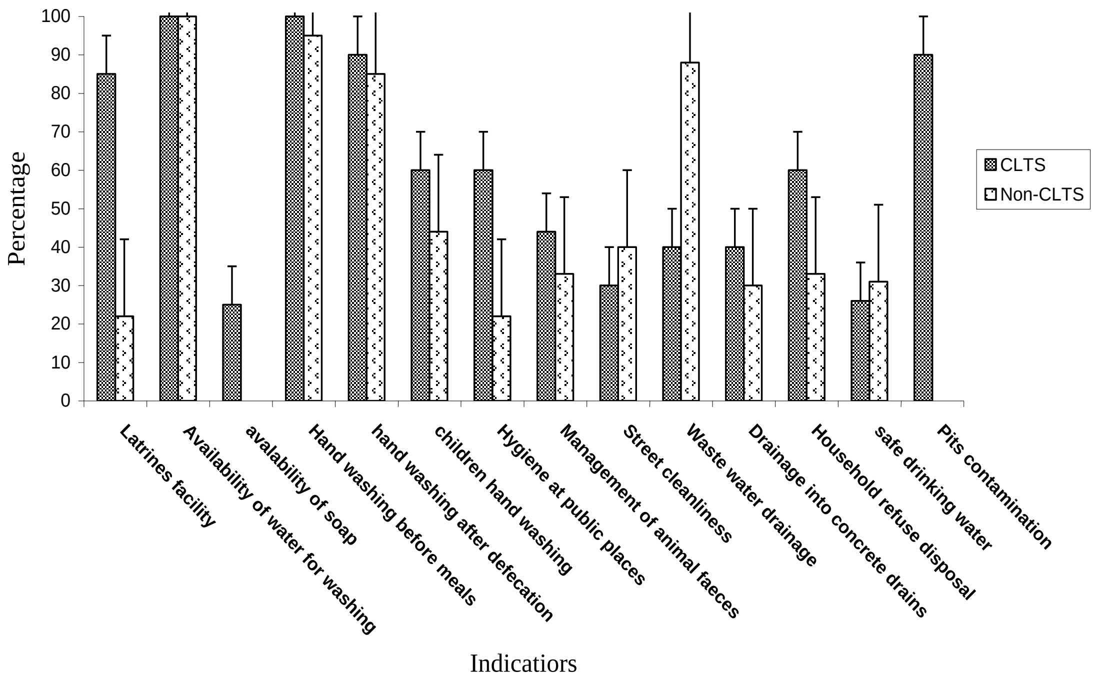

Figure 4. Comparison of hygiene practices between CLTS and non CLTS villages.

found that people in both types of villages use water for washing hands after urination if water is available. In the CLTS villages 60% children wash their hands and 40% don’t wash their hands, where as in the non-CLTS villages nearly 44% children wash their hands and 55%don’t wash their hands. It was found that 90% people washing their hands after defecation in CLTS villages while 85% people wash their hands after defecation in non CLTS villages as shown in Figure 4. According to the collected data, 60% of the public gathering places in the CLTS villages were clean, while in non-CLTS villages 22% public places were found clean. It shows that CLTS approach has greater role in improvement of hygiene in area which is a good indicator for behavior change.

Impacts of CLTS on health

The health data collected from the household was analyzed and it was found that the waterborne diseases are occurring mostly in the summer or with the season changes. This data was collected in the winter season so

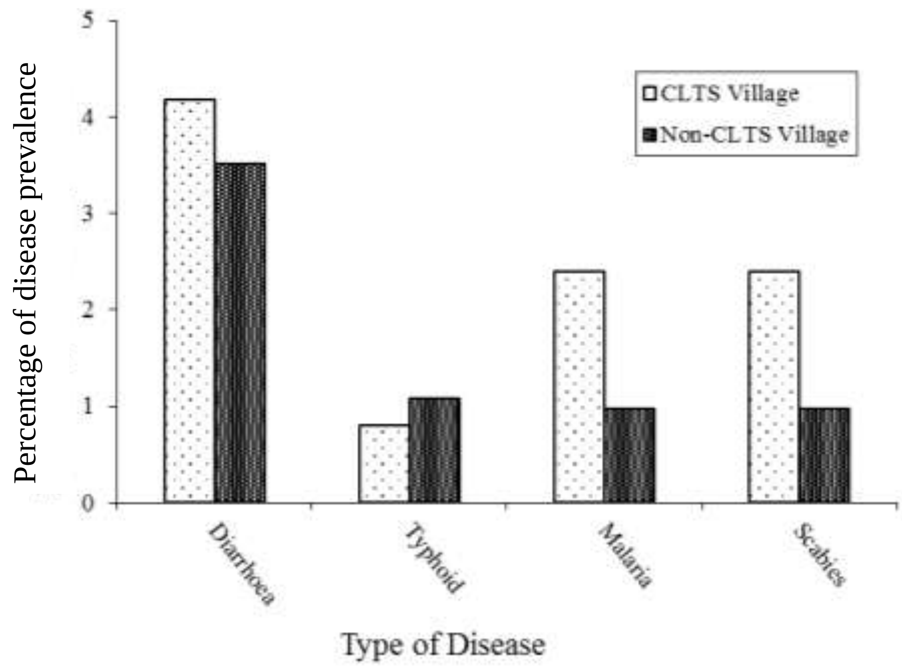

Figure 5. Comparison of disease incidences in the CLTS and non-CLTS villages.

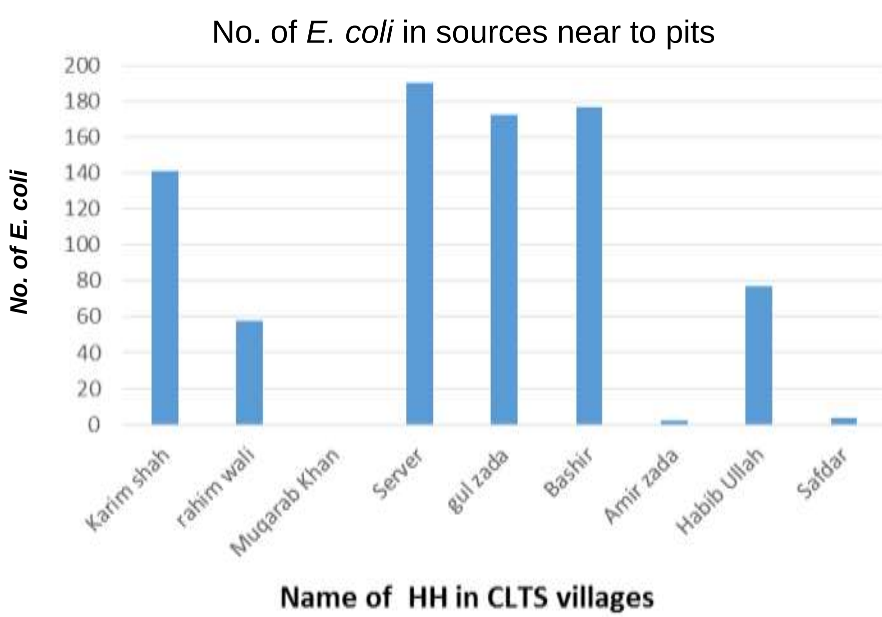

Figure 6. Number of *E. coli* in water sources near to pits.

enteric fever, flue and chest infections were also very high in addition to water borne diseases. In CLTS villages, it was found that, 4% people have diarrhea, 81% have typhoid, 2% malaria, 2% scabies, and 5% are other diseases. In non-CLTS villages, 3.5, 1, 1, 1 and 16% of diarrheal, typhoid, malaria, scabies and other diseases, respectively, were found as shown in Figure 5. The waterborne disease that were found during the field included diarrhea, typhoid, malaria and scabies. These diseases were found both in the CLTS and non-CLTS villages with different frequencies. According to Pedley and Howard (1997), contaminated groundwater can contribute to high morbidity and mortality rates from diarrhoeal diseases and sometimes lead to epidemics.

Normally, people have health problems especially fever and diarrhea. According to a person "*The diseases are prevailing due to dirty places".* It was found that most of water borne diseases was more common in summer season. Differences in these diseases have been shown in Figure 5. It was found that water borne disease incidences were more common in CLTS villages in comparison with the non CLTS villages. Other diseases were also found like unknown fever, tuberculosis and hepatitis. A CLTS specialist from local implementing partner organization shared that they use diarrhoeal diseases as an indicator to mobile community. For this purpose, they also collect the information from the 10% of the total household where they focus on women because women are involved in taking care of their children. According to CLTS specialist, 70% households are involved during triggering of CLTS in the villages.

Conclusions

This study was carried out in the perspectives of health, hygiene and groundwater quality situations in CLTS and non-CLTS villages. Results revealed an increase in groundwater contamination in CLTS implemented villages as compared to non-CLTS villages. Increased contamination was found in the water sources of those households who use pit latrines. It was observed that after CLTS intervention, people upgraded the pits into pour flush latrines as it was not that expensive and also a sign of status in the village. The impact on the hygiene is dependent upon the hygiene indicators and these indicators are dependent upon the behavior and the economic condition of the people. There was a positive change toward hygiene in CLTS implemented villagers. The impact of CLTS intervention on health incidences especially waterborne and water related diseases was not considerable as no changes in the improvement of health status of the people were found. People in the study area have so many cultural and economic challenges which weaken CLTS approach in the study area. After conducting this study, the researchers would like to recommend few points to be considered in future studies and CLTS implementing procedures for making this approach more results-oriented and sustainable.

RECOMMENDATIONS

(1) Soil structure and texture should be investigated before the CLTS interventions in rural areas
(2) The distance between the water source and the pits must be determined before the implementation of CLTS approach to avoid the seepage
(3) Water sources should be installed in the upstream, whereas latrines should be constructed at the downstream level to avoid flow of contaminants.
(4) The pits should be sealed with clay or any other material to prevent seepage in order to protect the underground water from contamination over the period of time
(5) Focus must be given to improvement of hygiene in addition to triggering for prevention of open defecation practices
(6) Further research is needed to be conducted on adsorption and infiltration rate of black water in different soils in the country.

Conflict of Interests

The authors have not declared any conflict of interests.

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