

Full Length Research Paper

Challenges of adoption of urine-diversion dry toilets technology as sanitation option by coastal communities of Mkuranga District in Tanzania

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Mkuranga District council in collaboration with African Medical and Research Foundation (AMREF) introduced ecological sanitation option using urine-diversion dry toilets (UDDT) to the community between 2007 and 2009, which was later declared unsuccessful. This study analyzed factors that hindered the uptake of UDDT by the community by assessing the project implementation strategy. Techniques used for the study were questionnaire, interviews, observation and focus group discussion while respondents were government official and the community at the household level. The study reveals that the literacy level in Mkuranga district is 79.1%, but only 40.6% had some knowledge of ecological sanitation although only 9% proves that. About 52% of the respondents are using conventional pit latrines, but 27.3% have no toilet facilities. There was no evidence of adoption of UDDT technology at household level and only one of the seven UDDTs constructed by the project is operational. There was no sufficient evidence to suggest that Mkuranga District has sufficiently supported the project through supervision, advocacy and addressing community requirements. As a result, the idea came in top-bottom approach which failed because communities were not adequately involved in the project.

Key words: Ecological sanitation, urine-diversion dry toilets, adoption, community participation, Tanzania.

INTRODUCTION

In many towns and rural areas of the world today, people live and raise their children in highly polluted environments (Muench, 2009). Urban and peri-urban areas in developing countries are among the worst polluted and disease ridden habitats of the world. Much of this pollution, which leads to high rates of disease and death, is caused by lack of toilets and inadequate sanitation services (COHRE et al., 2008). The lack of sufficient or adequate services is a result of many factors, including inadequate financial

resources, insufficient water and lack of space, difficult soil conditions and limited institutional capabilities. As population increases, the need for safe, sustainable and affordable sanitation systems will be even more critical (UNESCO/IHP, 2006).

In their Joint Monitoring Programme, UNICEF and WHO (2013) have reported that an estimated 2.5 billion people around the world do not have access to improved sanitation, the majority of those (90%) live in rural areas

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of Asia, Latin America and Africa. It is estimated that 1 billion people worldwide or 15% of world population still practice open defecation (UNICEF and WHO, 2013) including over 5 million people in Tanzania (UNICEF, 2013). In 2011, only 12% of Tanzanians use improved sanitation facilities (UNICEF and WHO, 2013), although others estimated household using improved sanitation are about 33% (Wikipedia, 2013) largely because of low investment in the sector. Although funding in water and sanitation sector has quadrupled since 2002 through multi-donor Water Sector Development Program (WSDP) (WSP and UNICEF, 2013), it is estimated that water supply and sanitation receives annual investment of US\$ 175 million only, which is equivalent to US\$ 4 per capita (Wikipedia, 2013). Even this little amount is spent largely on water supply only because subsidies for rural household sanitation are not supported by the Tanzanian government policy (WSP and UNICEF, 2013). As a result, individual households are encouraged to invest in their sanitation facilities.

Over the past hundred years, flush-and-discharge has been regarded as the ideal technology, particularly for urban areas (Esrey et al., 1998), although by 2007 only 3% of Tanzanian households use flush toilets (Wikipedia, 2013). For those without access to flush-and-discharge, the conventional alternative is a drop-and-store device, usually a pit toilet, based on containment and indefinite storage of human excreta (Esrey et al., 1998). However, water closets and pit latrines lack some important benefits as compared to ecological sanitation (Esrey et al., 1998). In accordance with Guadagni (2012), the ecological sanitation (EcoSan) approach does not promote a specific sanitation technology, but rather a new philosophy in recycling-oriented resource management, which renders human excreta safe, prevents pollution rather than attempting to control it, and uses the safe products of sanitized human excreta for agricultural purposes.

Ecological sanitation (EcoSan) have been practiced for thousands of years in China (Jurga et al., 2003; Smet and Sugden, 2006) and Japan has introduced the practice of using urine for agriculture about 900 years ago (Abarghaz et al., 2012). Today, application of EcoSan is common in the world over and in places such as in South Asia (Sridevi et al., 2007; WaterAid, 2008; Adhikari et al., 2012), Western Europe (Rhode et al., 2004; Tidaker et al., 2007; Rieck and Muench, 2011), Latin America (Thibodeau and Canaday, 2011), Eastern Europe, the Caucasus and Central Asia (Wendland et al., 2011). In recent years, EcoSan application have been reported in East Africa (Nuwagaba, 2003; Langergraber and Muellegger, 2005; Muellegger, 2011), West Africa (Kiba, 2005), South Africa (Mnkeni et al., 2008; Ingle et al., 2012) and North Africa (Abarghaz et al., 2012).

EcoSan offers a number of advantages including prevention of contamination of groundwater sources, prevention of degradation of soil fertility, provides nutrients to plants and reduces health risks related to sanitation

(Werner et al., 2004). They can be constructed on hard rock soils, suitable in areas with high ground water levels and areas prone to flooding. EcoSan is suitable where water is scarce or expensive and hence reduces the burden of the communities on looking for water to use for toilet purposes. In accordance with Langergraber and Muellegger (2005), EcoSan is a holistic sanitation approach that is economically and ecologically sound.

In 2007, Mkuranga District Council in collaboration with AMREF- Tanzania introduced urine-diversion dry toilets (UDDT) technology as a sanitation option with economic benefits. The technology was considered to be a solution to sanitation issues as it is clear that many people in the coastal area tend to practice open defecation, but the technology offers more advantages which go beyond the disposal of faeces (AMREF Mkuranga, 2007). In that project, a total of 7 UDDTs were constructed as a demonstration whereas 2 of them were constructed at a market place and 5 were constructed at the primary schools (Mkuranga District Council, 2008). A total of 560 artisans from 80 villages of Mkuranga were trained on how to construct affordable UDDTs (AMREF Mkuranga, 2009). The objectives of this study are to assess the UDDT project implementation strategy used and to determine setbacks which hindered the adoption of UDDT by the community.

METHODS AND MATERIALS

Description of the project

Mkuranga District has a total surface area of 2,432 km² out of which 447 km² is part of Indian Ocean, 552 km² is forest reserve and 1,433 km² of land is suitable for cultivation. It lies between latitude 6° 35' and 7° 30' South of the Equator and between longitudes 38° 45' and 39° 30' to the east. The district borders with Dar es Salaam Region, Indian Ocean, Rufiji District and Kisarawe District to the North, East, South and West, respectively (Figure 1).

The project started in 2007 by introducing urine diverted dry toilet (UDDT) as an option for ecological sanitation, which will reduce the portion of community using open defecation, a common sanitary method in the area. A three years project was implemented by Mkuranga District council together with their partners, African Medical Research Foundation (AMREF)- Africa. AMREF- Africa were committed to support the project financially by injecting about 100,000 USD and few human resource at the managerial level while Mkuranga District council were committed to provide technical support by giving out the expert to show their skills in both community mobilization, advocacy, technology experts as well as facilitators for capacity building to the community as an agent of sustainability. The expected major outcomes of the project were human behavioral changes, improvement of sanitation status of the community, improvement of agricultural productivity, reduction of communicable diseases and poverty alleviation.

Climate and soil

Mkuranga District is located south of Dar es Salaam along the west coast shores of Indian ocean. The district experiences bimodal rainfall with short rains season between October and December and long rains season covering the month of March to June

Map of Mkuranga showing Study Area

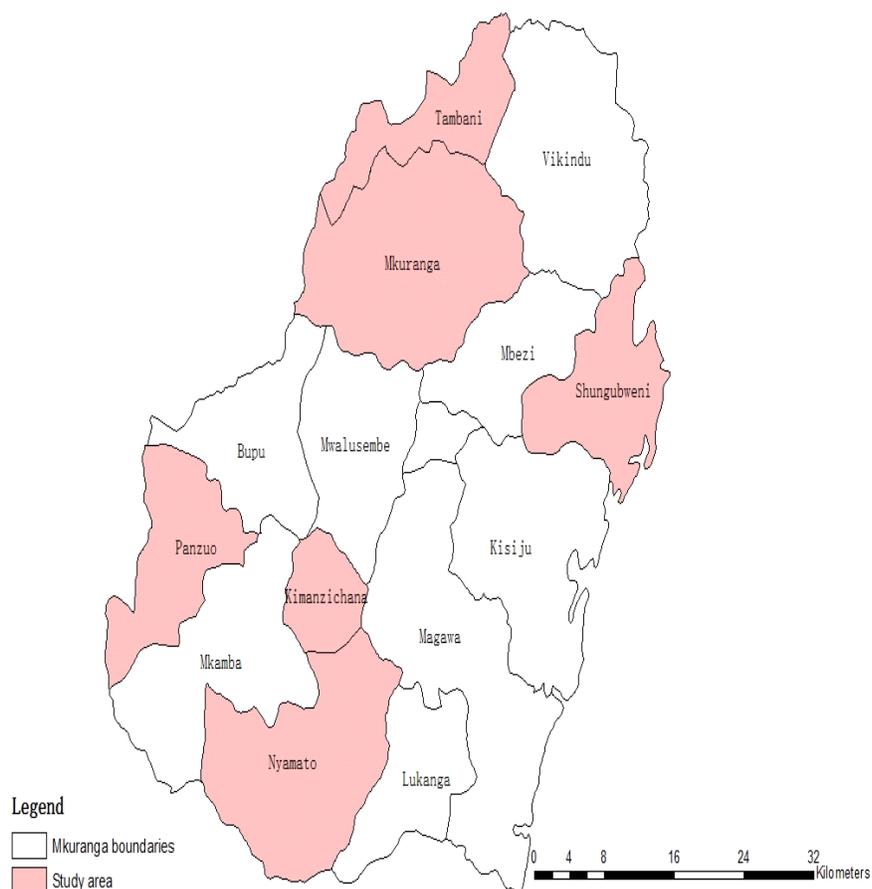


Figure 1. Map of Mkuranga District showing the study area.

(Majule, 2012). The average annual rainfall is about 800 – 1000 mm, but rainfall distribution is not very reliable within the seasons. It is hot throughout the year with average temperature of 28°C (Tanzania Meteorological Agency, 2013). Mkuranga like other parts of the coastal area of Tanzania is largely characterized by sandy soil, which collapses easily when dug, and high water table, which complicates construction of pit latrines (Mubarak, 2013).

Population and economic activities in Mkuranga

In accordance with population and housing census 2012, the district has a total population of 222,921 of which 114,897 (51.5%) are females and 108,024 (48.5%) are males (URT, 2013). The District population growth rate is 3.5% per annum (URT, 2013). The average population density of the District is 95 people per square kilometer, but large concentration of people is found at Kisiju, Magawa, Lukanga and Kitomondo wards due to a number of economic opportunities found in the area like fishing, trading, boat making and port activities. Wards along the main road from Dar es Salaam city to Lindi Region have urban characteristics. The per capita income of Mkuranga District in 2013 was 276.9 USD per annum, which is about 50% of the national per capita income of 550 USD per annum (1 USD = 1600 TZS in year 2013). About 85% of the district inhabitants depend on agriculture.

Sample size and sampling procedure

The sample size of this study was determined by the use of the formulae given by Krejcie and Morgan (1970) as shown by Equation 1.

$$n = \frac{X^2 \cdot x \cdot N \cdot P \cdot x (1 - P)}{[ME^2 \cdot x (N - 1)] \div [X^2 \cdot x \cdot P \cdot x (1 - P)]} \quad (1)$$

Where: n = sample size, X^2 = Chi-square for the specified confidence level at 1 degree of freedom ($X = 1.96$ for confidence interval of 95%), N = population size = 227,990, P = population proportion = 0.5, ME = desired margin of error = 5%. From the input data, the sample size of 360 was obtained.

Wards were selected using purposive sampling method and the respondents were selected using simple random sampling method and lottery technique from three wards located in urban setting (heterogeneous culture) and another three wards from rural settings (homogeneous culture). The number of respondents from each ward was determined proportionally to the population of the ward. Stratified random sampling technique were used to select respondents who were members in project steering committee at district level and ward level whereby groups for focus discussion were formed according to their level they belong (either ward or district level). These key informants participated in the establishment of

sanitation promotion project specifically introduction of UDDT within the district.

Data collection tools and processing

A self-administered structured close-ended questionnaire survey, observation (inspection visits) checklist (quantitative), focus group discussions (FGD) and semi-structured in-depth interviews (qualitative) were applied to collect primary data. Secondary data were collected from relevant reports and published research papers. Primary data were collected through administration of questionnaire at the household level; field observation by using observation checklist; interview and focus group discussion with key informant from the government both at the district and ward level as detailed in following sub-chapters. All these tools were pre-tested in Mkuranga ward and revised accordingly before they were used for the study population. The tools were first prepared in English and then translated into Kiswahili. Focus group discussions and semi-structured in-depth interviews were recorded with digital audio recording device. The collected data were entered in the computer and were analyzed using the Statistical Package for Social Science (SPSS) version 11.0 for Windows and Excel sheet. The data presentation forms include averages, frequencies percentages, charts and graphs.

Questionnaires for household

Households used as samples were obtained through a stratified random sampling procedure in accordance with Kothari (2004). Open and closed ended questions, which were prepared and administered to the household members in Swahili language, were designed to capture information on the knowledge, attitudes, perception and practices of the community members at household level with regards to sanitation promotion issues as well as strength, weakness and opportunity of UDDT. The questionnaires sought information on the type of latrine they are currently using, knowledge on ecological sanitation, knowledge on UDDT, their preference between UDDT versus the current latrine; views on UDDT promotion in the area; the possibility of handling dry faecal matter and urine from UDDT if there is any contradiction between their belief or opinion in using UDDT; whether they were involved in the establishment of the project; challenges related to UDDT and their advice for the uptake of the technology. The questionnaires also sought information on demographic data, economic status, household size, occupation, marital status, education level and age of the respondent, duration of their stay in that community and nature of the house tenure.

Key informant interviews

This involved district project steering committee to supplement data from the questionnaires with the help of an interview guide. The government officials involved in the study was District Health Officer; District Water Engineer; District Planning Officer; District Community Development Officer; District Environmental Sanitation Officer; District Education officer; District Agricultural and Livestock Development Officer and District Treasurer. These interviews were aimed at getting an overview of sanitation management in the district by focusing on the coordination of the different stakeholders and challenges faced in the establishment and implementation of sanitation project in the district. It was also a tool to reveal if all necessary steps in the project were taken as well as the participatory approach was fully observed in all stages of the project.

Table 1. Age distribution.

Age	Frequency	Percent
18 - 25 years	42	12.4
26 - 35 years	94	27.6
36 - 55 years	113	33.2
56+	91	26.8
Total	340	100.0

Focus group discussion

Two sets of six people each were formed; one group with officials from three wards with urban setting characteristics and another group includes officials from ward with rural setting characteristics. Each ward was represented by two government officials (Ward Executive Officer and Ward Health Officer). The aim of the focus group discussions was to gather strengths and weaknesses of the project and the response of the people toward the adoption of the technology.

RESULTS AND DISCUSSION

About 340 respondents from the household level, 8 respondents from the district level and 12 respondents from the ward level participated in the study. The demographic data of the respondents from the household indicate that male respondents were 202 (59.4%) while female respondents were 138 (40.6%). The marital status of the respondents were married 72.1% (n=245), single 13.2% (n=45), separated 7.9% (n=27), divorced 3.5% (n=12) and widowed 3.2% (n=11). About 243 (71.5%) of respondents were head of the household and the remaining 97 (28.5%) were just mere members of the household. Table 1 shows the age distribution of the respondents.

Socio economic profile

Source of income

Mkuranga District is fast growing economically because of its close proximity (about 30 to 40 km) with Dar es Salaam City. It has attracted many investors including 9 new industries, which were launched in recent years. This industrial growth within the district has led to the increase of employed people even with its nature of rural setting. Table 2 shows that the majority of the residents of Mkuranga in the surveyed area are peasants (42.7%), although the proportion reported in this study is much lower than 62% reported by Mkuranga District Council (MDC strategic plan, implementation report 2011) and 89.6% reported by National Bureau of Statistics (URT, 2013). This was probably influenced by the large number of respondents who came from the wards which possess urban characteristics. In these areas, most of the people

Table 2. Occupational distribution.

Occupation	Number of respondents	Marginal percentage
Employed	103	35.8
Petty business	38	13.2
Other small industries	24	8.3
Peasant	123	42.7
Total	288	100.0

Table 3. Educational level.

Level	Number of respondents	Percent
Primary school	130	38.2
Secondary school	98	28.8
Tertiary education	41	12.0
Illiterate	71	20.8

are engaged in employment and business. About 62% of those employed are unskilled laborers who earn less than Tshs 150,000/=(about USD 94 in 2013) per month. Self-employment is largely through petty businesses, which may only sustain them in very basic needs such as food and house supplies. Peasants in Mkuranga District own small farms where they cultivate short term crops such as cassava, and perennial crops such as coconuts, mangoes and oranges. Peasants also engage in other economic activities such as fishing whose contribution to their income was not established (MDC report, 2011).

Education level

Table 3 shows that the literacy level is 79.1% (38.2% for primary school, 28.8% for secondary school and 12.0% for tertiary education), which is sufficient for the introduction of new knowledge. Data from the National Bureau of Statistics (TDHS, 2011) indicate that literacy level varies from 78 to 83% depending on the level of urbanization of the area, gender and geographical zones, suggesting that Mkuranga District has the lowest literacy level in Tanzania. In the latest National sensor carried out in 2012, it was reported that only 43% of Mkuranga District residents are literate owing to low rate (51%) of children enrolment rate. It is worth to note that educational level of the community is one of the factors determining the success of a community projects in terms of planning, designing and implementation of new project. Fruman et al. (2012) reported that education was identified as one of the most crucial factors that will lead to acceptance and use of UDDT in rural Georgia. Tumwebaze and Niwabaga (2011) reported that respondents with secondary and tertiary education were 2 to 5 times more likely to adopt to ecological sanitation than respondents with primary

education. In another study, Nuwabaga (2003) observed that Ecosan coverage was low among people with primary education level (0.4%) than people with tertiary education (13%).

House tenure

Data from National Bureau from Statistics indicate that only about 20.8% of houses in Mkuranga district are roofed with corrugated iron sheets or tiles, while others (79.2%) are largely thatched roof houses (URT, 2013). Similar findings were reported by Torell and Mmochi (2006) who observed that most residents of Mkuranga District live in poor and simple houses thatched by coconut leaves or grass, poles, and mud walls on earth floors. The houses are also largely comprised of a mixture of huts with walls made of mud and wooden poles (94.7%), as well as conventional bricks and block houses (5.3%), which are traditionally found in wards of urban characteristics like Mkuranga town. Many people in the district are of low income with 89.6% depending on subsistence agriculture for their livelihood. Only 0.6% of the population is connected to electricity. As a result, 98% of the population is depending on charcoal and firewood as a source of energy (URT, 2013). It was observed that about 57.4% of the respondents own houses, whereas 42.7% of the respondents are living as tenants. Most of the tenants (79%) are found in wards, with urban characteristics and the majority of tenants (65%) are employees who normally shift from one working station to another. House tenure is very important aspect in designing the sanitation project as its implementation will need decision, consent and resource investment from the owner of the house either by having a mutual agreement with the tenants or the owner to incur all the "sanitation investments" cost on his structure.

Sanitation (UDDT) project

Project organization

Figure 2 shows the organizational framework of the project. During interview with key informants, it was revealed that the setup of the project meant to be fully participatory as

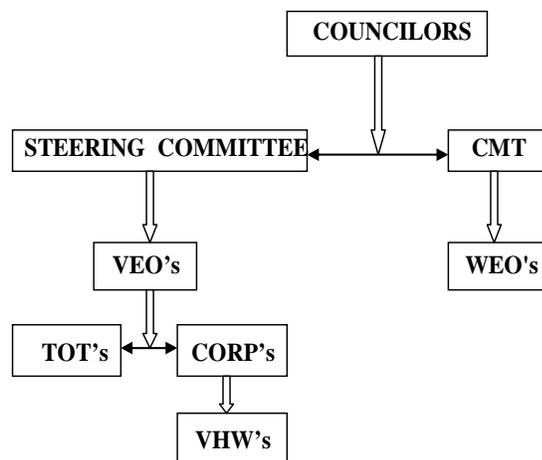


Figure 2. Project hierarchy.

Table 4. Types of latrines used in the study area.

S/N	Type of latrine	Percent of respondents
1	Cistern flush toilet	5.6
2	Conventional pit latrines	52.1
3	Ventilated Improved Pit Latrines	13.2
4	Pour flush toilets	1.8
5	No latrines	27.3

every level at the local government in the district was included. These include councilors, head of departments and steering committee members, which comprises of various professionals at the district level; such as Ward Executive Officers (WEOs), Village Executive officers (VEOs) as well as community member under the title of Trainer of Trainee (TOTs), Community Own Resource Person (CORPs) and the Village Health Workers (VHWs).

The steering committee members at the district level and members of the community (trainers of trainees, community own resource persons and village health workers) were involved in daily activities of the project, but other stakeholders participated only in meetings. In focus group discussions, key informants (District Health Officer, District Planning Officer and District Water Engineer) revealed that the project was mainly supervised by only few members of the steering committee, but there was no evidence suggesting that councilors and heads of departments and ward leaders were involved in the supervision of the project. It was also observed that village executive officers worked as either trainers of trainees or community own resource persons instead of project supervisors at village level in order to earn allowances, which compromised the quality of the work.

Status of latrine use

Table 4 shows that the majority of the respondents (52.1%) are using conventional pit latrines. Other types of latrines used in the study area include ventilated improved pit latrines (13.2%), cistern flush toilet (5.6%) and pour flush toilet (1.8%), but no single UDDT was found at household level. In fact, in the whole study area, the only operational UDDT was found at a primary school, which was one of the seven UDDTs constructed by the project. The remaining six UDDTs constructed during project implementation as demonstration toilets were out of use, which suggests that the technology was completely abandoned instead of being adopted.

It is worth mentioning that the type of sanitation options used by the respondents is related to availability of water in the area and the level of economy and education of the users. For example, water closets were found in Mkuranga town where level of income of community is high and water is available for flushing wastes although tap water in Mkuranga town is unreliable. In wards located in rural areas where water supply is not available, conventional pit latrines are common. In accordance with national population and housing sensors carried out in 2012, only 8.7% of households in Mkuranga District use piped or protected well/spring water as the main source of drinking water (URT, 2013), which is comparable to the proportion of households using cistern and pour flush toilets (7.4%).

The results also show that 27.3% of respondents do not have latrines, suggesting that they are probably using open defecation because community latrines are not available in the area. These findings are similar to those reported by the National Bureau of Statistics (TDHS, 2011) which reported that 22% of household do not have latrine, but differs with those of MDC report (2011) who reported that only 8% of the household do not have latrine. Other reports indicate that over 60% of Mkuranga District households do not have latrines particularly near coastal areas (Towell and Mmochi, 2006). The records from Joint Monitoring Programme conducted by UNICEF and WHO (2013) suggest that in 2011 about 16% of people in rural Tanzania practice open defecation. It is therefore evident that sanitation situation in Mkuranga district is below the average sanitation level of rural Tanzania. Some of the potential reasons are the level of literacy (43%) of Mkuranga District residents, which is among the lowest in the country.

It is worth noting that 69.3% of households, which do not have toilet, are located in a coastal ward of Shungubweni, suggesting that they are using beaches of Indian Ocean for defecation. This factor along with sandy soils in the area, which complicate excavation and construction of the pits, was mentioned by 68% of the steering committee members during interview and focus group discussions. Fortunately, UDDTs do not require deep pits suggesting that soil type is not the cause of failure of the project. It was further observed that about

Table 5. Sources of information on ecological sanitation (sample size = 340).

S/N	Source of information	Population reached	
		Number	Percent
1	Awareness campaigns	188	55.3
2	Community meetings	83	24.4
3	Friends and/or relatives	50	14.6
4	News media	19	5.7

11% of the interviewed head of departments mentioned some culture barriers such as those which restrict in-laws from sharing toilets. Other key informants (23%) mentioned poverty as an obstacle to latrine construction, due to inadequate resources and the habit of the latrine to collapse. A report by Torell and Mmochi (2006) indicated that less than 40% of households in Mkuranga District have toilets partly because of latrine construction difficulties caused by sandy collapsible soil and inadequate enforcement of public health and sanitation regulations and weak by laws. As a result, Mkuranga District Integrated Coastal Management (ICM) Action plan recognized that beach area, which is being used for open defecation and garbage dumping, is a major sanitation issue.

Literature studies have shown that open defecation is influenced by many factors including cultural behavior (Mubarak, 2013; Ashebir et al., 2013), cleanliness of toilet facility (Tumwebaze et al., 2014), poverty, shortage of water supply, lack of housing and illiteracy (Balamurugan et al., 2013). In another study by Pradhan and Heinonen (2010) in Central Nepal, it was observed that hygienic practices are influenced by the level of education largely because of lack of awareness among different socio-economic strata. A research by Ashebir et al. (2013) suggest that it is not enough to provide people with sanitation hardware because they may not be used by the intended users, which correspond to the observation made in this study. Numerous approaches have been suggested in literature to tackle the sanitation software part, which provide behavioral change interventions corresponding to psychological factors to be changed (Mosler, 2012).

Knowledge on ecological sanitation (UDDT)

It was revealed that only 82 of 340 respondents (24.1%) have knowledge of EcoSan. Of the 82 respondents who have knowledge of EcoSan, 46 respondents (55.3%) were informed of ecological sanitation through awareness campaigns and another 20 respondents (24.4%) through community meetings (Table 5). Generally, project initiative disseminated information on ecological sanitation to only 60 of 340 respondents (17.6%), which is contrary to the report given by AMREF (2009) which indicates that more than 63% (143,633 of 227,990 population of Mkuranga)

were aware of the sanitation project particularly UDDT technology. It was further observed that an additional 12 of 82 respondents (14.6%) got the information from friends or relatives and the remaining 4 of 82 respondents (5.7%) got the information from news media. Field survey proved that only 7 of 82 respondents (9%) knew slightly more than the hearing ecological sanitation.

During the interviews with district officials and focus group discussion with ward officials, it was noted that the steering committee excluded social worker and community development personnel in the project and involved people who were not well informed on ecological sanitation to facilitate the training, sensitization campaigns and advocacy meetings at the community level. During the interview with district officials including steering committee members, it was noted that 4 of them have no idea of new participatory approaches used in sanitation projects, suggesting that participatory was not used during the early stages of the project. As a result, the project failed to reach significant number of people from the target group to stimulate changes within the community. It is therefore evident that there was inadequacy of disseminated and organized advocacy for the technology contributed to its lack of uptake of technology in Mkuranga district by the users.

In accordance with WHO and UNICEF (2009), it is important to allow time for communities to adapt to new technology. Research work in Kabale Uganda indicated that 82% of the respondents in the project area were knowledgeable of EcoSan, which influence 20% of them to use the technology (Tumwebaze and Niwagaba, 2011). In accordance with Tumwebaze and Niwagaba (2011), at least 80% of the community is required to know the new technology in order to influence 20% of them to accept it. Elsewhere, Ashebir et al. (2013) reported that 54.5% of respondents having latrines in Tigray, Ethiopia did not use them at all and only 37.4% of respondents use latrines consistently. Even in more developed countries like European countries, UDDT technology particularly reuse of urine and feces, was initially considered a strange concept by the users (Fruman et al., 2012). Therefore, proper education and training of the communities must be done in order to overcome initial misconceptions that individual have.

Preference of latrine currently used versus UDDT

Table 6 shows the respondents' willingness to convert their existing toilet facility to UDDT. This data was gathered from 81 of 82 respondents who know EcoSan toilets. It was observed that only 1 of 14 respondents (7.1%) who are using flush sanitation (cistern and pour) are willing to convert to UDDT, but 21 of 68 respondents (30.9%) using pit (ventilated and conventional) latrines are willing to use UDDT. Overall, 27.2% of respondents who know EcoSan are willing to convert their current sanitation facility to UDDT, although none have adopted

Table 6. Willingness of converting current latrine into UDDT (n = 81).

Current latrine facility	Number of respondents using this type of latrine	Respondents using this type of toilet	
		Number	Percent
Conventional pit toilet	49	13	26.5
Ventilated improved pit toilet	19	8	42.1
Cistern flush toilet	10	1	10.0
Pour flush toilet	3	0	0
Total	81	22	27.2

Table 7. Views on UDDT promotion.

	Frequency	Percent
Not good idea	138	40.6
Good idea	64	18.8
Don't know	138	40.6
Total	340	100.0

UDDT because of inadequate practical knowledge of EcoSan. In India, Balamurugan et al. (2013) observed that communities using pit sanitation have more adaptability towards EcoSan as it functions far better than what they use in all aspects including health, reuse, hygienic, aesthetics and user-friendliness than pit sanitation. However, flush sanitation has put barriers to changing over to EcoSan as the concept is entirely different.

It was revealed that only 18.8% of the community considered UDDT technology favorably, 40.6% of the community did not support the introduction of UDDT technology and another 40.6% were not committed (Table 7). This was largely because of inadequate practical knowledge of UDDT technology. In accordance with Niwagaba (2003), the community with inadequate knowledge on UDDT, tend to consider it as impure and therefore reject it. However, Nekesa (2007) in his study at Wakiso sub-county in Uganda reported that most of the people in rural area prefer UDDT as an option in sanitation.

Community views on UDDT promotion

Handling and uses of dried faeces and urine

This survey showed that out of 340 respondents, only 70 (20.5%) were willing to handle dried faeces and urine. It was observed that those who rejected handling of excreta did because of various reasons such as nuisance (24%), religious restrictions by Muslims (57.6%) and fear of infectious diseases and lack of knowledge on ecological sanitation (18%). Rosenquist (2005) in analysis of psychosocial of the human-sanitation nexus observed that before dissemination of the knowledge of ecological

sanitation, people have a tendency of rejection of the product from the sanitation options. It is therefore not uncommon for people to reject products from sanitation options and handling of excreta, but this is expected to change with improved knowledge on ecological sanitation. It has been documented that usage of decomposed excreta as manure in farmland is difficult to adapt as households fear odour and infectious diseases (Balamurugan et al., 2013). However, a small group within the community could act as a catalyst to changes towards sanitation promotion (Tumwebaze and Niwagaba, 2011). Therefore, the group which shows interest in using UDDT products could easily understand the benefits of the technology hence adopt it.

During focus group discussion, it was revealed that the project employed Participatory Hygiene and Sanitation Transformation (PHAST) approach as a tool to create sense of ownership to the community for sustainability of the project. While it is known that PHAST process is effective at spreading a multitude of health and hygiene messages, it is expensive, relies on donor agencies and non-governmental organizations and has weaknesses of bringing the intended improved and sustained hygiene behaviours (Binamungu, 2007). Various approaches proved to work better depending on environment, society itself and the geographical settings such as urban and rural (MoHSW, 2010). Community led total sanitation (CLTS) which is more suitable in rural setting could be the choice for area with rural setting characteristics while community led urban environmental sanitation (CLUES) which is jointly developed by EAWAG, the Water Supply and Sanitation Collaborative Council (WSSCC) and UN-HABITAT in 2010, could work better in areas with urban setting characteristics.

About 64.5% of the respondents who are willing to handle dry faeces and urine from UDDT said that they will use the product for agricultural purposes while 16% said that they can use the product for some other purposes such as business. It is worth to note that about 20% of the respondents, who refuses to handle dry faeces and urine, are willing to use it. More than 17% are ready to use it in agricultural purpose and more than 2% could use for other purpose. This finding indicates that people are willing to use dry faeces and urine, which could be a motive for them in adopting the technology.

Table 8. Challenges of UDDT.

Challenge	Percent
Technical problems	8.8
Social and religious beliefs	64.7
Financial problems	15.3
Don't know	11.2
TOTAL	100.0

UDDT challenges

About 64.7% (220 of 340) respondents consider social and religious beliefs as a major challenge for adoption of the technology. Other challenges are financial (15.3%), technical (8.8%), but the remaining 11.2% did not have opinions (Table 8). Mkuranga District is mostly dominated by Muslims who considered both urine and faeces as unholy and therefore rejected the idea from the beginning of the project. However, in accordance with Tumwebaze and Niwagaba (2011) more than 30% of the people who adopted UDDT in Kabale, Uganda were Muslims. They further reported that similar challenges were observed among the Muslim communities during the initial stage of the project, but the adoption gradually improved through advocacy. Ecological sanitation has also been used in other Muslim communities such as Pakistan (Nawab et al., 2006). In accordance with Muench (2009), UDDTs are suitable for various cultural settings: they can be designed to suit both sitting and squatting cultures and to cope with the use of water for wet anal cleaning cultures as well. Müllegger (2011) in innovative UDDT designs from East Africa provided various designs of UDDT, some of which have the provision for using water as anal cleansing materials. Similarly, Rosemarin et al. (2007) have suggested ecological sanitation systems that accommodate water as anal cleansing material. Unfortunately, there was no strong evidence to suggest that advocacy and demonstration of UDDT, which allow water to be used as anal cleansing material, was done in Mkuranga District.

About 15.3 % of respondents consider UDDT as more expensive than other toilets. This is contrary to the study done by Nekese (2007) in Wakiso, Uganda where UDDT were reported to be cheaper, affordable and comfortable as it excludes flies and smell. The same finding also were revealed by the study done in Pakistan on preference in designing ecological sanitation systems in north west frontier province, where EcoSan toilets were preferred by the local residents; showing that open defecation was a sign of poverty (Nawab et al., 2006). This discussion shows that there is a chance for UDDT to be adopted by even low income community, but will only be possible if the knowledge were properly disseminated and the community are well exposed to all design of the technology.

Table 9. Community advice on UDDT uptake.

S/N	Community advice	Percent
1	Technology adjustment	20.6
2	Availability of technical expertise	13.5
3	Affordability of technology	26.8
4	I do not know	39.1
5	Total	100.0

Technical problems also were considered to be a challenge by 8.8% of the respondents although during the initial stage of the project, a total of 560 artisans were trained from 80 villages. This is equivalent to 7 artisans per village in almost 70% of the villages in the district, which is a very positive start. However, during focus discussion, it was revealed that currently only 134 artisans are still in the district, but have shifted to towns where they are working as artisans. It was further reported that the selection process of artisans was biased as most of them were handpicked by the village leader and some of the steering committee member for personal rather than technical reasons.

To improve technology uptake by the community, the respondents requested for affordable designs (26.8%), the adjustments of technology to accommodate water as anal cleansing material (20.6%) and availability of technical expertise such as artisans (13.5%). It was noted that 133 of 340 respondents (39.1%) did not have comments on what should be done to influence the adoption of EcoSan technology largely because they do not have practical knowledge of the technology (Table 9). It was noted that although EcoSan was potentially cheaper than other latrines, the issue of affordability was raised by about 26.7% of respondents. It is possible that this group either lack some important information concerning the designs of EcoSan toilets or they do not currently have toilets. In fact, about 11% of the respondent claimed that they have not used or seen UDDT before because demonstration toilet was poorly located.

For new technology to be adopted by the users, it is important that all constraints that may restrict its adaptability such as religious, cultural, legal and financial constraints be identified at the planning stage of the project. This may include involving communities during planning and implementation stages of the project, which is considered as very important because it builds a sense of ownership and commitment among the local people (IRC, 2003; Mayo and Nkiwane, 2013). Evidence of recruitment and training of local masons in the project was available, but the stakeholders were not sufficiently involved in the project. Effort of applying participatory hygiene and sanitation transformation (PHAST) method similar to the one used at Majumbasita in the neighboring district of Ilala (Chaggu, 2002) was not evident in this

project. Among the constraints that require information include attitudes of the people to reuse treated human excreta as manure and the responsibilities of various institutions for development of Ecosan with the relevant policies, by-laws, budgets and target levels have to be identified. It is also worth mentioning that financial obstacle, may be one of the constraints for adoptability of Ecosan in Mkuranga District bearing in mind that the district is one of the poorest in the country. In such cases, government subsidies may prove a success provided consumers also contribute to a reasonable extent.

Conclusions

From the study the following conclusions were drawn:

1. District leaders (including councilors) abandoned the project by allowing steering committee to work, supervise and even audit their own transactions. It was further observed that the participatory approach used was not effective. As a result, there was no evidence of the technology adoption in the district.
2. Religious and cultural barriers for adoption of UDDT were observed. Such barriers may only be removed by disseminating the correct information to residents by committed, experienced and knowledgeable personnel. Unfortunately, the personnel from the project were not conversant with ecological sanitation, which was one of the reasons for failure to disseminate the proper contents meant to reach the community.

Conflict of interests

The authors did not declare any conflict of interest.

REFERENCES

- Abarghaz Y, Mahi MM, Werner MC, Bendaou N, Fekhaoui M (2012). Ecological sanitation in Morocco Promotion of the Urine-Diversion Dehydration Toilets- A case study of Dayet Ifrah. *Am. J. Environ. Sci.* 8(3):212-219.
- Adhikari RU, Islam M, Tuladhar B, Shakya SK, Thakur KK (2012). Operation and maintenance challenges to promote dry toilet: A case of ENPHO EcoSan implementation area in Nepal. Fourth International Dry Toilet Conference, Tampere, Finland.
- AMREF-Mkuranga (2007). UDDT baseline report, Mkuranga District council.
- AMREF-Mkuranga (2009). Annual report, Mkuranga District council.
- Ashebir Y, Sharma HR, Alemu K, Kebede G (2013). Latrine use among rural households in northern Ethiopia: A case study in Hawzien district, Tigray. *Int. J. Environ. Stud.* 70(4):629-636.
- Balamurugan J, Ravichandran M, Nithiya PT (2013). Ecological sanitation and green economy. *Int. J. Sci. Res.* 2(10):1-4.
- Binamungu B (2007). Towards Meeting National and MDG sanitation targets: A review of sanitation status in Tanzania, Water and Sanitation Program, Dar es Salaam, Tanzania.
- Chaggu E (2002). Ecological sanitation toilets in Tanzania. Third International conference on Integrated Environmental management in Southern Africa, Johannesburg, South Africa.
- COHRE, WaterAid, SDC and UN-HABITAT (2008). Sanitation: A Human Rights. Development Studies and Monograph Series 20. Washington: World Bank DRAFT (2002/3), Dar es Salaam: Economic Research Bureau.
- Esrey SA, Gough J, Rapaport D, Sawyer R, Simpson-Hébert M, Vargas J, Winblad U (1998). Ecological Sanitation; Department for Natural Resources and the Environment, Sida, S-105 25 Stockholm, Sweden.
- Fruman Y, Wendland C, Samwel A, Deegener S (2012). Acceptance of UDDTs in eastern Europe, Caucasus and Central Asia. Fourth International Dry Toilet Conference, Tampere, Finland.
- Guadagni A (2012). Embedding Innovative Sanitation Technology: An Assessment of Urine Diversion Dry Toilets in Bangladesh, Technische Universität – Berlin.
- Ingle R, Berdau S, Kleemann F, Arndt P (2012). What does it take to convince decision makers in Omaruru, Namibia to scale up urine diversion dehydration "Otji toilets"? Fourth International Dry Toilet Conference, Tampere, Finland.
- IRC (2003). Community water supply management: About community management. Available online at <http://www2.irc.nl/manage/whatisit/index.html>. Accessed on 25th March 2015.
- Jurga I, Gallinat B, Mang H (2003). Implementation of a closed-loop sanitation concept in Yang Song township, China. Proceedings of the 2nd International Symposium in Ecological Sanitation, April 7-11, Lubeck, Germany, 843-848.
- Kiba DI (2005). Agronomic valorization of the human excreta: Use of the urine and faeces for the production of aubergine (*Solanum melongena*) and of the corn (*Zea mays*) in the center zone of Burkina Faso. Thesis, Polytechnic University of Bobo Dioulasso.
- Kothari CR (2004). Research methodology: Methods and Techniques, Second Edition, New Age International Publishers, New Delhi, India.
- Krejcie RV, Morgan DW (1970). Determining Sample Size for Research Activities. *Education and Psychological Measurement* 30: 607-610.
- Langergraber G, Muellergger E (2005). Ecological sanitation – a way to solve global sanitation problems? *Environ. Int.* 31:433-444.
- Majule AE (2012). Implications of ecological and social characteristics to community livelihoods in the coastal areas of Tanzania. *Afr. J. Environ. Sci. Technol.* 6(1):72-79.
- Mayo AW, Nkiwane L (2013). The role of community participation on cost recovery and sustainability of rural water supply projects in Hai District, Tanzania. *J. Environ. Sci. Water Resour.* 2(11): 388 - 395.
- Ministry of Health and Social Welfare (MoHSW) (2010). Annual report on Food, Water and Sanitation.
- Mkuranga District Council (2008). Annual report, Health department, Prevention section.
- Mkuranga District Council (2011). Annual report, Health department, Prevention section.
- Mkuranga District Council (2011). Strategic Plan, Implementation report.
- Mnkeni PNS, Kutu FR, Muchaonyerwa P, Austin LM (2008). Evaluation of human urine as a source of nutrients for selected vegetables and maize under tunnel house conditions in the Eastern Cape, South Africa. *Waste Manage. Res.* 26:132-139.
- Mosler HJ (2012). A systematic approach to behavioral change interventions for water and sanitation sector in developing countries: A conceptual model, a review, and a guideline. *Int. J. Environ. Health Res.* 22(5):431-449.
- Mubarak T (2013). Requirements and Challenges of UDDT for Technology Uptake by Coastal Communities: A case of Mkuranga Project- Tanzania, Masters of Sanitation Management Dissertation, Department of Water Resources Engineering, University of Dar es Salaam.
- Muench E (2009). Urine-Diversion Dehydration Toilets. Eschborn: German Agency for Technical Cooperation (GTZ) GmbH.
- Müllerger E (2011). Innovative urine diverting dry toilet (UDDT) designs from East Africa; EcoSan Club Austria: Vienna, Austria. *Sustain. Sanit. Pract.* 6:10-14.
- National Bureau of Statistics (2011). Tanzania Demographic and Health survey (TDHS); Final report 2010.
- Nawab B, Nyborg ILP, Esser KB, Jenssen PD (2006). Cultural preferences in designing ecological sanitation systems in North-west frontier, Pakistan. *J. Environ. Psychol.* 26: 236-246.
- Nekeša J (2007). Community response towards ecological sanitation- Analysis of knowledge based adoption levels among the community

- of Kasanje subcount, Wakiso district (Uganda), Project Report, SNV Uganda, West Nile portfolio.
- Nuwagaba A (2003). Assessment of factors that influence household's choice of sanitation technologies and excreta re-use (EcoSan), Kampala. Water and Sanitation Program, Makerere Institute of social research.
- Pradhan S, Heinonen TH (2010). Knowledge and awareness of eco-sanitation in central Nepal: A questionnaire survey. *Environ. Dev. Sustain.* 12: 713-726.
- Rhode L, Stintzing AR, Steineck S (2004). Ammonia emissions after application of human urine to a clay soil for barley growth. *Nutr. Cycl. Agroecosyst.*, 68:191-198.
- Rieck C, Muench E (2011). Technology review of urine diversion dehydration toilets (UDDTs), Design principles, urine and faeces management, Eschborn, Germany; Available at http://www.ecosanres.org/discussion_group.htm. Accessed on 25th March 2015.
- Rosemarin A, Kvarnström E, Subbaraman M, Ganapathy V, Dagerskog L, Pasupathiraj K (2007). Ecosan systems that accommodate anal washing. *Sustainable Water Management*, Issue 2-2007. Available at <http://www2.gtz.de/Dokumente/oe44/ecosan/en-analwashing-2007.pdf>. Accessed on 25th March 2015.
- Rosenquist LED (2005). A psychosocial analysis of the human-sanitation nexus. *J. Environ. Psychol.* 25(3): 335-346.
- Smet J, Sugden S (2006). Ecological Sanitation: Well Factsheet. Available at <http://www.lboro.ac.uk/well/resources/fact-sheets/fact-sheets-htm/Ecological%20sanitation.htm>. Accessed on 25th March 2015.
- Sridevi G, Srinivasamurthy CA, Bhaskar S, Viswanath S (2009). Evaluation of source separated human urine (ALW) as a source of nutrients for banana cultivation and impact on quality parameter. *J. Agric. Biol. Sci.* 4:44-48.
- Tanzania Meteorological Agency (2013). Mean monthly temperature and rainfall variation data.
- Thibodeau C, Canaday C (2011). Elegant yet economical urine diverting dry toilets in Ecuador. *Sustain. Sanit. Pract.* 6: 23-28.
- Tidaker P, Mattsson B, Jonsson H (2007). Environmental impact of wheat production using human urine and mineral fertilizers- a scenario study. *J. Clean Prod.* 15: 52-62.
- Torell E, Mmochi A (2006). Mkuranga Governance Baseline, Coastal Resources Center, University of Rhode Island, p. 18.
- Tumwebaze IK, Niwagaba CB (2011). Ecological sanitation uptake knowledge, beliefs and practices in Kabale Municipality, Kabale district; The future of Water, Sanitation and hygiene; Innovation, adaptation and engagement in changing World; 35th WEDC international conference, University of Loughborough, UK.
- Tumwebaze IK, Niwagaba CB, Günther I, Mosler HJ (2014). Determinants of households' cleaning intention for shared toilets: Case of 50 slums in Kampala, Uganda. *Habitat International*, 108-113.
- UNESCO/IHP (2006). Capacity building for ecological sanitation; Concepts for ecologically sustainable sanitation in formal and continuing education. International Hydrological Programme (IHP) of the United Nations Educational, Scientific and Cultural Organisation (UNESCO); 1 rue Miollis, 75732 Paris Cedex 15, France and the Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH Dag Hammarskjöld Weg 1-5, 65760 Eschborn, Germany.
- United Nations Children Education Fund (UNICEF) (2013). Water, Sanitation and Hygiene: WASH - Fast Facts. Available at http://www.unicef.org/tanzania/WASH_factsheet.pdf. Accessed on 25th March 2015.
- United Nations Children Education Fund (UNICEF) and World Health Organization (WHO) (2013). Progress on Sanitation and Drinking Water – 2013 Update. WHO and UNICEF Joint Monitoring Programme for Water and Sanitation. Available online at http://www.who.int/iris/bilstream/10665/81245/1/9789241505390_eng.pdf. Accessed on 25th March 2015.
- United Republic of Tanzania (URT) (2013). Population and Housing Census 2012. population Distribution by Administrative Areas. national Bureau of Statistics, Dar es Salaam, March 2013.
- Water and Sanitation Program (WSP) and United Nations Children Education Fund (UNICEF) (2013). Water Supply and Sanitation in Tanzania: Turning Finance into services for 2015 and beyond. An AMCOW Country Status Overview. Available at <http://www.wsp.org/sites/wsp.org/files/publications/CSO-Tanzania.pdf>. Accessed on 25th March 2015.
- WaterAid (2008). Ecological sanitation latrines: The experience of Nepal. Fieldwork paper. WaterAid in Nepal, Kathmandu, Nepal. Available at WaterAid webpage. Accessed on 25th March 2015.
- Wendland C, Deegener S, Jorritsma F (2011). Experiences with urine diverting dry toilets (UDDTs) for households, schools and kindergarten in Eastern Europe, the Caucasus and Central Asia. *Sustain. Sanit. Pract.* 6:16-22.
- Wikipedia (2013). Water supply and sanitation in Tanzania. Available at http://en.wikipedia.org/wiki/Water_supply_and_sanitation_in_Tanzania. Accessed on 25th March 2015.