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Article *in* Journal of Water, Sanitation and Hygiene for Development · June 2014

DOI: 10.2166/washdev.2014.126

4 authors:

Eugene Appiah-Effah
Kwame Nkrumah University Of Science and Technology

Kwabena Nyarko
Kwame Nkrumah University Of Science and Technology

Samuel Fosu Gyasi
University of Energy and Natural Resources

Esi Awuah
University of Energy and Natural Resources


Volume 1 Number 1 January 2011
ISSN 2043-9083
Journal of
Water, Sanitation and
Hygiene for
Development
IWA
Publishing

Faecal sludge management in low income areas: a case study of three districts in the Ashanti region of Ghana

Eugene Appiah-Effah, Kwabena Biritwum Nyarko, Samuel Fosu Gyasi and Esi Awuah

ABSTRACT

The challenge of faecal sludge management (FSM) in most developing countries is acute, particularly in low income areas. This study examined the management of faecal sludge (FS) from household latrines and public toilets in three districts in the Ashanti region of Ghana based on household surveys, key informant interviews and field observations. Communities did not have designated locations for the disposal and treatment of FS. For household toilets, about 31 and 42% of peri-urban and rural respondents, respectively, with their toilets full reported that they did not consider manual or mechanical desludging as an immediate remedy, although pits were accessible. Households rather preferred to close and abandon their toilets and use public toilets at a fee or practise open defecation. For the public toilets, desludging was manually carried out at a fee of GHC 800–1,800 and the process usually lasted 8–14 days per toilet facility. The study showed that FSM has not been adequately catered for in both peri-urban and rural areas. However, respondents from the peri-urban areas relatively manage their FS better than their rural counterparts. To address the poor FSM in the study communities, a decentralized FS composting is a potential technology that could be used.

Key words | desludging, faecal sludge management, peri-urban area, rural area

Eugene Appiah-Effah (corresponding author)
Civil Engineering Department,
Kwame Nkrumah University of Science and Technology,
Kumasi, Ghana
E-mail: *appiaheffah@yahoo.com*

Kwabena Biritwum Nyarko
Civil Engineering Department,
Kwame Nkrumah University of Science and Technology,
Kumasi, Ghana

Samuel Fosu Gyasi
Environmental Engineering Department,
University of Energy and Natural Resource,
Sunyani, Ghana

Esi Awuah
Office of the Vice-Chancellor,
University of Energy and Natural Resource,
Sunyani,
Ghana

INTRODUCTION

The challenge of faecal sludge management (FSM) in most developing countries is acute. A large proportion of the thousands of tons of sludge generated daily from onsite sanitation systems is not well managed. The faecal sludge (FS) from unsewered family and public toilets and septic tanks are disposed of untreated indiscriminately into lanes, drainage ditches, onto open urban spaces as well as into inland waters, estuaries and the sea (Montangero & Strauss 2004). This improper practice of FS disposal is a growing environmental and sanitary concern, since many waterborne diseases are transmitted from faeces to humans through water and soil pollution (Kengne *et al.* 2011).

About 85% of the Ghanaian population is served with onsite sanitation systems (EAWAG & SANDEC 2006), including latrines, non-sewered public toilets and septic tanks. The onsite systems accumulate sludge and therefore need regular desludging when full. However, faecal sludge treatment (FST) facilities are not adequate to deal with the large quantities of FS generated from these onsite sanitation systems. Thus, FS are not properly managed. FS from an onsite sanitation system (wet or dry) may be disposed of onsite or offsite (WHO 2006). In Ghana, as is typical of developing countries, the available sanitation facilities are overstretched and FSM is poor (Cofie *et al.* 2003). Only 14% of Ghana's population use improved sanitation facilities with 19% practicing open defecation and 58% using shared facilities (WHO/UNICEF 2012). Sewered excreta disposal systems are rare due to high costs and lack of adequate

doi: 10.2166/washdev.2014.126

water supply (Cofie *et al.* 2004). The few FST facilities available are not able to treat the large tons of sludge generated. It is reported that out of 44 sewage treatment facilities (including seven FS and Septage Treatment Plants) only seven are functioning adequately (MLGRD 2010). These FST facilities are located in Accra, Kumasi, Tema and Akosombo, which have some form of sewer system. Keraita *et al.* (2002) observed that the amount of FS collected in Kumasi is half of what is expected, while that of Accra is dramatically low. Almost all the rest of the FS is discharged into the environment untreated (Kuffour *et al.* 2013). This situation of FSM is not uncommon in the peri-urban and rural settlements of Ghana as these areas lack access to adequate basic sanitation facilities, thus relying more on unimproved sanitation facilities.

Research efforts to address FS challenges in developing countries include the use of FS as industrial fuel, as a source to produce biogas, as a component in building materials and as a soil conditioner or fertilizer (Gold *et al.* 2013).

Research on FSM in urban areas is widely known whereas the situation in rural and peri-urban is not adequate. The study therefore seeks to assess FSM in low income areas (peri-urban and rural areas) in the Ashanti Region of Ghana. The specific study objectives are to: (1) identify the toilet technologies and household sanitation practices; (2) assess households' perception of hygiene practices and FS reuse; and (3) investigate current FSM practices in terms of desludging, treatment and disposal.

MATERIALS AND METHODS

Study area

The study was conducted in three peri-urban and three rural areas (see Box 1) selected at random from three districts. These are the Bosomtwe District, Ejisu Municipality and the Kumasi Metropolitan Assembly (KMA), all in the Ashanti region (see Figure 1). The peri-urban areas selected were Appeadu (KMA), Feyiase and Pramso (Bosomtwe District). Apromase (Ejisu Municipality). Abrankese and Onwi (Bosomtwe district) were also considered as rural communities.

Box 1 | Definition of terms

Peri-urban areas can be described as those immediately adjoining urban areas, localized outside formal urban boundaries and urban jurisdictions, which are in the process of urbanisation. The peri-urban areas are also seen as an interface between the urban and rural areas, also called the transition zone or interaction zone.

Rural areas are settled places outside towns and cities and they are distinct from more intensively settled urban and peri-urban areas. These are normally characterized by low population densities, small surface area of the land cover and relative isolation with agricultural production as the major economic activity.

Source: NETSSAF (2008).

The Bosomtwe District and Ejisu Municipality are located in the central portion of Ashanti region. Both fall within the equatorial zone with a rainfall regime typical of the moist semi-deciduous forest zone of the country. KMA is located in the transitional forest zone and falls within the moist semi-deciduous south-east ecological zone. The sanitation situation in the district, municipality and metropolitan areas is not satisfactory as only few communities have access to improve latrines with the majority relying on traditional pit and public latrines (see Table 1).

Research methods

The study used desk studies, key informant interviews, household surveys and field observations. The use of multiple complementary methods made it possible to triangulate to eliminate bias (Adubofour *et al.* 2012). The protocols used in the study were approved by the Departmental Ethics Committee.

Key informant interview

Face-to-face interviews were conducted with assembly men (elected officials at the District Assembly), public toilet attendants and the Water and Sanitation Management Teams to collect a wide range of information regarding the

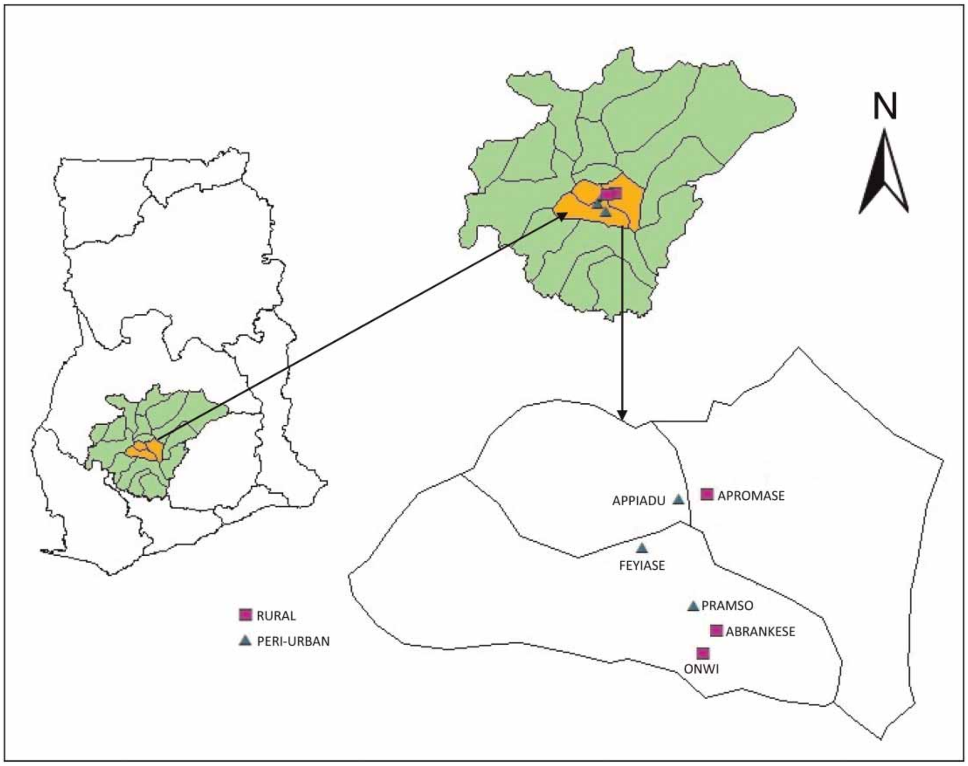

Figure 1 | A map of Ghana (Left), map of Ashanti Region (Top Right) and map of three selected districts showing GPS locations of study communities.

Table 1 | Toilet facilities available to dwelling units by district

	No facility	Private WC	Private pit latrine	Private KVIP	Private bucket/ pan latrine	Public toilet	Other
District:							
KMA	2.5	40.1	10.7	7.1	0.3	38.8	0.4
Bosomtwe	5.7	9.3	25.3	11.1	0.3	48.1	0.3
Ejisu	6.4	12.2	21.5	10.4	0.2	48.8	0.4

Source: Ghana Statistical Service 2012.

Table 2 | Key informants and data collected

Key Informant	Number interviewed	Data collected
Assemblymen	2 per community	Community demography, general sanitation situation and challenges with FSM issues
Public toilet attendants	2 per community	Description and cleanliness of public toilet, toilet user fees, and other FSM issues
Water and Sanitation Management Teams	1 team per community (7–11 members per team)	General sanitation situation, main toilet technologies, FSM issues

FSM situation of the communities (see Table 2). The meetings were recorded and later transcribed.

Household survey

The purpose of the household survey was to determine the socioeconomic profile of the respondents (including sex, age, marital status, educational level and reported monthly household income), perception of sanitation practices, FS reuse and FSM (desludging, treatment and disposal). Questionnaires were designed, tested and administered to 45 households in a community for six communities in the study area. In all, household questionnaires were administered to 270 households. Asante Twi, the main local language, was used during the household interviews.

Field observation

A transect walk and visual inspection were used to observe the FSM situation and also triangulate secondary data collected and responses made by key informants and households from the interviews. Observations were carried out early in the mornings and in the evenings when households were at home and use of household and public toilets were at their peak. A stick was used to check whether toilets were full or not.

Data analysis

Questionnaires were entered manually using Microsoft Excel 2007. All the data entered were cross-checked manually with the corresponding question to ensure that data entered were accurate and of high quality. Descriptive statistics using percentages and Chi-square test were used to establish associations between categorical variables. Two-tailed tests were used with $p < 0.05$ considered significant.

RESULTS

Demography of respondents

Respondents to the questionnaires consisted of males and females with ages from 20 to 89 years with 28.5% being

Table 3 | Respondents' demographic data stratified by type of settlement

Variables	Total 270 (%)	Peri-urban 135 (%)	Rural 135 (%)	*p*-value
Sex				
Male	104 (39)	49 (36)	55 (41)	0.2265
Female	166 (61)	86 (64)	80 (59)	0.4530
Age (years)				
20–29	57 (21.1)	30 (22.2)	27 (20.0)	0.6546
30–39	77 (28.5)	43 (31.9)	34 (25.2)	0.2251
40–49	61 (22.6)	33 (24.4)	28 (20.7)	0.4668
50–59	37 (13.7)	16 (11.9)	21 (15.6)	0.3762
60–69	27 (10.0)	10 (7.4)	17 (12.6)	0.1556
70–79	10 (3.7)	3 (2.2)	7 (5.2)	0.1974
80–89	1 (0.4)	0 (0)	1 (0.7)	0.3164
Marital status				
Single	63 (23.3)	28 (20.7)	35 (25.9)	0.3138
Married	171 (63.3)	93 (68.9)	78 (57.8)	0.0582
Divorced	7 (2.6)	4 (3.0)	3 (2.2)	0.7017
Separated	8 (2.9)	4 (3.0)	4 (3.0)	
Living-in	3 (1.1)	0 (0)	3 (2.2)	0.0816
Widowed	18 (6.7)	6 (4.4)	12 (8.9)	0.0716
Educational level				
No formal education	30 (11.1)	9 (6.7)	21 (15.6)	0.0201
Basic	79 (29.3)	31 (23.0)	48 (35.6)	0.0230
Junior high school	115 (42.6)	67 (49.6)	48 (35.6)	0.0194
Senior high school	31 (11.4)	20 (14.8)	11 (8.1)	0.0858
Tertiary	15 (5.6)	8 (5.9)	7 (5.2)	0.7905
Employment status				
Subsistence farming	105 (38.9)	16 (11.9)	89 (65.9)	<0.0001
Trading	129 (47.8)	96 (71.1)	33 (24.4)	<0.0001
Public service	24 (8.9)	13 (9.6)	11 (8.1)	0.66890
Private organization	12 (4.4)	10 (7.4)	2 (1.5)	0.01820
Household size				
1–3	74 (27.4)	31 (23.0)	43 (31.9)	0.10160
4–6	131 (48.5)	69 (51.1)	62 (45.9)	0.39400
7–9	47 (17.4)	27 (20.0)	20 (14.8)	0.26120
10–12	13 (4.8)	6 (4.4)	7 (5.2)	0.77620

(*continued*)

Table 3 | continued

Variables	Total 270 (%)	Peri-urban 135 (%)	Rural 135 (%)	*p*-value
>12	5 (1.9)	2 (1.5)	3 (2.2)	0.65170
Household income (GHC/ month)				
<100	80 (29.6)	24 (17.7)	56 (41.5)	<0.0001
100–199	79 (29.3)	38 (28.1)	41 (30.4)	0.68820
200–299	50 (18.5)	27 (20.0)	23 (17.0)	0.53090
300–399	18 (6.7)	13 (9.6)	5 (3.7)	0.05100
400–499	17 (6.3)	15 (11.1)	2 (1.5)	0.00110
>/ = 500	26 (9.6)	18 (13.3)	8 (5.9)	0.03910

p: *p*-value $p < 0.05$ is significant, $p > 0.05$ is not significant. Values in parenthesis within the main table represent various percentages. NA: Question not applicable to respondent, GHC is Ghana cedis. 1 USD = GHC 2.00.

30–39 years. The majority of these were married (63.3%), had education at least up to junior high school level (42.6%) with a small proportion (4.4%) engaged by private organizations. Within the study population, 48.5% of the respondents also had a household size of 4–6 with a proportion of these (29.6%) earning less than GHC 100 per month (see Table 3).

Respondents demographic data, when stratified by location, showed that 49.6% of peri-urban dwellers had education up to junior high school level compared to 35.6% of respondents from rural communities ($p = 0.0194$) (see Table 3). Of the respondents, 6.7% of peri-urban dwellers had no formal education compared to their counterparts in rural areas (15.6%) ($p = 0.0201$). When the employment status was stratified by settlement type, the results showed that a fewer proportion of respondents in peri-urban areas (11.9%) were subsistence farmers compared to 65.9% in the rural dwelling ($p < 0.0001$) (see Table 3). However, there were more traders in the peri-urban areas (71.1%) compared to 24.4% in the rural ($p < 0.0001$). There were about 8% of respondents in peri-urban communities who earned their living working with private organizations compared to less than 2% from rural communities (see Table 3). The study showed that 41.5% of respondents in the rural areas earned less than

Table 4 | A comparative analysis of respondents household sanitation practices based on location

Variables	Total 270 (%)	Peri-urban 135 (%)	Rural 135 (%)	*p*-value
Mode of discharge of toilet				
Public toilet	188 (69.6)	85 (63.0)	103 (76.3)	0.01720
Private/ household toilet	71 (26.3)	50 (37.0)	21 (15.6)	< 0.0001
Open defecation	11 (4.1)	0 (0)	11 (8.1)	0.00070
Toilet type				
VIP	43 (15.9)	33 (24.4)	10 (7.4)	0.00010
KVIP	122 (45.2)	85 (63.0)	37 (27.4)	< 0.0001
Traditional pit latrine	71 (26.3)	0 (0)	71 (52.6)	< 0.0001
WC with Septic tank	23 (8.5)	17 (12.6)	6 (4.4)	0.01650
NA	11 (4.1)	0 (0)	11 (8.1)	0.00070
Age of toilet				
1–3	32 (11.9)	20 (14.8)	12 (8.9)	0.13200
4–6	27 (10.0)	21 (15.6)	6 (4.4)	0.00230
7–9	5 (1.9)	3 (2.2)	2 (1.5)	0.65170
10–12	4 (1.5)	4 (3.0)	0 (0)	0.04390
> 12	3 (1.1)	2 (1.5)	1 (0.7)	0.56150
NA	11 (4.1)	0 (0)	11 (8.1)	0.00070
Don't know	188 (69.6)	85 (63.0)	103 (76.3)	0.01720
Number of people using toilet				
1–3	15 (5.6)	7 (5.2)	8 (5.9)	0.79050
4–6	36 (13.3)	26 (19.3)	10 (7.4)	0.00420
7–9	18 (6.7)	16 (11.9)	2 (1.5)	0.00060
10–12	3 (1.1)	1 (0.7)	2 (1.5)	0.56150
> 12	0 (0)	0 (0)	0 (0)	
NA	11 (4.1)	0 (0)	11 (8.1)	0.00070
Don't know	188 (69.6)	85 (63.0)	103 (76.3)	0.01720
Frequency of visit to toilet in a day				
Once	178 (65.9)	91 (67.4)	87 (64.0)	0.60750
Twice	79 (29.3)	43 (31.9)	36 (26.0)	0.34910
Three times	4 (1.5)	1 (0.74)	3 (2.0)	0.31370
NA	11 (4.1)	0 (0)	11 (8.0)	0.00070

(*continued*)

Table 4 | continued

Variables	Total 270 (%)	Peri-urban 135 (%)	Rural 135 (%)	*p*-value
Payment of user fees				
Yes	94 (34.8)	85 (63.0)	9 (7.0)	< 0.0001
No	111 (41.1)	0 (0)	111 (82.0)	< 0.0001
NA	65 (24.1)	50 (37.0)	15 (11.1)	< 0.0001
Cost of public toilet user fee (Gp)				
5	0 (0)	0 (0)	0 (0)	
10	69 (25.6)	60 (44.4)	9 (7.0)	< 0.0001
20	25 (9.4)	25 (18.6)	0 (0)	< 0.0001
NA	175 (64.8)	50 (37.0)	125 (93.0)	< 0.0001

Gp is Ghana pesewas.

GHC 100 per month compared to 17.7% of their peri-urban counterparts ($p < 0.0001$).

Household sanitation practices

The results of household sanitation practices showed that the majority of rural respondents (76.3%) relied on public toilets as their main toilet option compared to 63.0% from the peri-urban areas ($p = 0.0172$). The percentage of respondents in the peri-urban communities who used their own toilet (37%) was higher than their counterparts in the rural areas who used their own toilet (15.6%) ($p < 0.0001$). Nobody from the peri-urban communities defecates openly, as compared to 8.1% of respondents from the rural communities ($p = 0.0007$) (see Table 4). The study also showed that the majority of respondents from peri-urban areas (63.0%) patronized the KVIP latrine as compared to the rural respondents (27.4%) ($p < 0.0001$). Of the respondents who used a ventilated improved pit (VIP) latrine, 24.4% were from the peri-urban areas while only 7.4% were from rural areas (see Table 4). The majority of respondents from the rural areas (52.6%) used the traditional pit latrine. Of the respondents from the peri-urban areas, 15.6% had toilet facilities aged from 4–6 years compared to 7.4% of respondents from the rural areas ($p = 0.0042$). The results of the study further showed that 63.0% of respondents from peri-urban areas paid some form of user fees before accessing public toilets compared to 7.0% of their rural counterparts ($p < 0.0001$).

Hygienic behaviour and FS reuse

Analysis of results of hygienic behaviour and FS reuse showed that the majority of respondents in the peri-urban areas (60%) used toilet tissue (see Table 5). Of peri-urban respondents, 77.8% had their toilets regularly cleaned compared to 16.3% in the rural areas ($p < 0.0001$). About 92% of the respondents reported that they practise hand washing with soap each time after visiting the toilet, compared to 76.3% from the rural areas ($p = 0.0005$). The results showed that none of the respondents reused FS for any beneficial purpose, including agriculture. However, these respondents reported that they would be willing to reuse FS when it is treated for agriculture (see Table 5).

Table 5 | Respondents' hygienic behaviours and sludge reuse stratified by settlement type

Variables	Total 270 (%)	Peri-urban 135 (%)	Rural 135 (%)	*p*-value
Type of anal cleansing material used				
Paper	148 (54.8)	54 (40.0)	94 (69.6)	< 0.0001
Toilet tissue	122 (45.2)	81 (60.0)	41 (30.4)	< 0.0001
Cleanliness of toilet				
Regular	127 (47.0)	105 (77.8)	22 (16.3)	< 0.0001
Not regular	99 (36.7)	16 (11.9)	83 (61.5)	< 0.0001
No cleaning	33 (12.2)	14 (10.3)	19 (14.1)	0.35290
NA (open defecators)	11 (4.1)	0 (0)	11 (8.1)	0.00070
Hand washing with soap after visiting toilet				
Yes	227 (84.1)	124 (91.9)	103 (76.3)	0.00050
No	43 (15.9)	11 (8.1)	32 (23.7)	0.00050
Reuse of sludge for agricultural purposes				
Yes	0 (0)	0(0)	0 (0)	
No	66 (24.4)	50 (37.0)	16 (11.9)	< 0.0001
NA (no household toilets)	204 (75.6)	85 (63.0)	119 (88.1)	< 0.0001
Willingness to reuse sludge for agricultural purposes				
Yes	221 (81.9)	103 (76.3)	118 (87.4)	0.01790
No	49 (18.1)	32 (23.7)	17 (12.6)	0.01790

Regular: cleaning done twice a day; not regular: cleaning done but not as arranged; no cleaning: no arrangements made for cleaning.

FS treatment and disposal

Assessment of FSM practices revealed that there were no designated disposal and treatment site in the study districts. In the peri-urban areas, only 3.7% of the respondents had desludged their toilets whilst 33.3% have never desludged their toilets. However, of the 33.3% who had never desludged their toilets, 10.3% add chemicals, particularly dichlorodiphenyltrichloroethane (commonly referred to as DDT) and calcium carbide to their FS. In the rural areas, out of 15.6% respondents with household toilets, none had desludged their toilet whilst 2.2% add chemicals such as DDT and calcium carbide to their FS (see Table 6).

Table 6 | Methods of faecal sludge treatment and disposal stratified according to settlement type

Variables	Total 270 (%)	Peri-urban 135 (%)	Rural 135 (%)	*p*-value
Place of sludge disposal				
Sludge sent to disposal site outside community	5 (1.9)	5 (3.7)	0 (0)	0.02400
Bush	0 (0)	0 (0)	0 (0)	
Buried in pits	0 (0)	0 (0)	0 (0)	
No designated disposal site in community	61 (22.6)	45 (33.3)	16 (11.9)	< 0.0001
NA	204 (75.6)	85 (63.0)	119 (88.1)	< 0.0001
Treatment of sludge				
Yes	22 (8.1)	19 (14.0)	3 (2.2)	0.00040
No	44 (16.3)	31 (23.0)	13 (9.6)	< 0.0001
NA	204 (75.6)	85 (63.0)	119 (88.2)	< 0.0001
Method of sludge treatment				
Treatment site/WSP	5 (1.9)	5 (3.7)	0 (0)	0.02400
Chemicals	17 (6.3)	14 (10.3)	3 (2.2)	0.00590
No treatment	34 (12.6)	31 (23.0)	3 (2.2)	< 0.0001
NA	214 (79.3)	85 (63.0)	129 (95.6)	< 0.0001
Desludging of toilet facilities				
Yes	5 (1.9)	5 (3.7)	0 (0)	0.02400
No	66 (24.4)	45 (33.3)	21 (15.6)	0.00070
NA	199 (73.7)	85 (63.0)	114 (84.4)	< 0.0001
Mode of desludging				
Manual labour	0 (0)	0 (0)	0 (0)	
Mechanical	5 (1.9)	5 (3.7)	0 (0)	0.02400
NA	265 (98.1)	130 (96.3)	135 (100.0)	0.02400

DISCUSSION

Demography of respondents

From the study, female respondents dominated male respondents in both peri-urban and rural areas and this may be due to the high percentage of females in the Ashanti region. The age group of the majority of respondents suggest the population of the study areas is young and falls within the economically active group (KMA 2006). The situation of early marriages and early births, mostly in rural and peri-urban communities, cause children to come of age early and start their own families (Adubofour *et al.* 2012) and this might have impacted on the high percentage of married respondents. The majority of respondents in rural areas involved in subsistence farming compared to peri-urban respondents could have influenced the high proportion of no formal education in the rural communities. These household demographics are consistent with the Ghana Statistical Service report (GSS 2012).

The Ghana Living Standard Survey defines poverty (in terms of economic index) as households subsisting on a monthly income less than GHC 102. The survey found about 18% and 42% of households from peri-urban and rural areas, respectively, as being poor. This, however, did not come as a surprise because the majority of respondents from both peri-urban and rural areas were employed in the informal sector that is either subsistence farming or trading. This assertion is true as the International Labour Organization reported that informal sector employees seldom attract substantial incomes to cater for the needs of their families (ILO 2004).

Household sanitation practices

Onsite sanitation systems and open defecation were the main mode of toilet discharge in both peri-urban and rural areas. The proportion of peri-urban respondents with household toilets was higher compared to the rural respondents, who used public toilets and other unimproved means of defecation. Similarly, the usage of KVIP and VIP latrines were more in the peri-urban compared to the rural areas. This could be partly due to the availability of more KVIP and VIP latrines in the peri-urban than the rural areas. There was no reported case of open defecation in the peri-urban areas compared to 8.1% in the rural areas. These findings were inconsistent with the results of research carried out by Antwi-Agyei *et al.* (2011) who reported that 4% of people in Madina (peri-urban community) practised open defecation. Education, awareness creation and enforcement of sanitation bye laws might be relevant in addressing the problem of open defecation in rural areas.

Adubofour *et al.* (2012) reported that it takes an average of 4.2 years for each toilet pit in Kumasi to fill up, dependent on pit volume and the number of people using it. Interviews and field observations, however, showed that household toilets (KVIP, VIP and WCs with a septic tank) take about 6–10 years to fill up. This study established the low frequency of visits to the toilet by both peri-urban and rural respondents, which is once a day, which could have influenced the variation in pit fill up rate. The toilet user fees charged could partly be the reason for the significant number of rural areas practising open defecation. This confirms the findings of other studies (Keraita *et al.* 2003) in communities of similar characteristics. The majority of peri-urban respondents paid user fees before accessing public toilets compared to their rural counterparts. This was not surprising as the income levels of participants from the peri-urban communities were higher compared to their rural counterparts. Interviews with some key informants also confirmed that most of the rural areas were poor and could not afford the toilet user charges. These results emphasize the need to provide targeted subsidies for the poor in communities to provide them the opportunity to access public toilets.

Hygienic behaviour and FS reuse

SWASH+ (2009) reported that toilet tissue is the preferred anal cleansing material. A higher proportion of the peri-urban respondents reported using toilet tissue compared to those in the rural areas. People are reluctant to use toilet facilities when the sanitary conditions of the toilets are poor. The proportion of rural dwellers who defecated into the open compared with none from the peri-urban communities could be partly as a result of the lack of regular cleaning of the facilities, which creates bad sanitary conditions. This was also confirmed during key informant interviews in the rural areas. The bad sanitary conditions could be managed by ensuring regular and adequate cleaning of toilets before peak times (usually in the early mornings and evenings). Education and awareness creation could also be essential in addressing the bad sanitary conditions. Hand washing is one of the most effective means of preventing diarrhoeal diseases (Curtis & Cairncross 2003). Only a few of the respondents from the peri-urban areas risk contracting any diarrhoeal disease since the majority of them reported that they wash their hands with soap each time after visiting the toilet compared to their rural counterparts.

FS is reused as compost in low and middle income countries, mainly for the benefits of recycling plant nutrients and enhancing soil characteristics. The study surprisingly showed that none of the households interviewed reused FS as compost for any beneficial purpose such as agriculture. This is in contrast with previous studies conducted in some households in five farming communities in the Tamale Municipal area where most of the households used FS as fertilizer on their farms (Cofie *et al.* 2004). In both the peri-urban and rural areas, the respondents indicated that they would be willing to reuse treated FS for agriculture. The willingness to reuse FS as compost agrees with the proposal in the Ghana Environmental Sanitation Policy (MLGRD 2001), which recommends composting as an appropriate FST method for daily sludge volumes less than 50 cubic metres.

FS treatment and disposal

FST and disposal is a principal component of environmental sanitation. There were no designated locations for the disposal and treatment of FS in both rural and peri-urban areas. However, none of the respondents disposed of FS indiscriminately into the environment, which was also confirmed by field visits and interviews with the assembly men. A few of the peri-urban respondents dispose of FS at an approved location, 40 km outside the communities. This is because there are no cesspit emptying operators in the communities.

Although results from the study showed that about one-third of peri-urban dwellers had not desludged their household toilet facilities, field observations revealed that 31% of those who had their toilets full (VIP toilets) required immediate desludging. Similarly, 42% of rural dwellers who had not desludged their household toilets actually had their toilets full. The few peri-urban respondents who used a WC with a septic tank desludged their toilets mechanically. Households who had not desludged their toilets did not consider either manual or mechanical desludging as an immediate remedy. Rather, they preferred to close and abandon the toilet and resort to the use of public toilets at a fee (peri-urban 63%; rural 11%) or practise open defecation (peri-urban 37%; rural 89%). Potentially decentralized FS treatment facilities could be located close to the poor communities to reduce the cost of desludging. Households complained of high mechanical desludging fees of GHC 200–400 per trip, as a result of which they resorted to using public toilets at a fee or abandoned the toilet. Moreover, manual desludging was not a preferred option for all the households due to its associated challenges, though it was a cheaper option compared with the mechanical method. The challenges were that the method was not aesthetically pleasing, the toilet cannot be used while desludging, it usually takes about 3–5 days, operators normally lack appropriate equipment, and the attendant health risks associated with it. For manual FS removal, the sludge is removed by using a bucket tied to a rope and the content transferred into pits and buried. Desludging is done usually by 2–4 men who charge GHC 150–300 for household VIP toilets. Potential options for addressing FS may include a decentralized compost toilet that can produce sludge for agriculture.

The public toilet attendants from the study areas indicated that the toilets are desludged on an average frequency of 1–2 year intervals, dependent on user population and rate. Although accessibility to public toilet facilities was not a problem, mechanical desludging operators could not operate effectively due to the disposal of materials such as plastics, bottles and stones into the pit which clogs the pipes and hoses of the emptying trucks and often cause it to breakdown. The majority of the public toilets (6/8) were therefore manually desludged and the process usually lasted for 8–14 days per toilet facility. During this period, the toilet is closed to public use and individuals are left to find other means of defecation. Manual operators charge fees of GHC 800–1,800 for desludging one public latrine compared to GHC 1,200–2,100 for mechanical desludging. It takes about 4–7 trips for trucks to fully empty a public toilet. The mode of desludging largely depended on the characteristics of the sludge, whether dry or wet. Disposal of unapproved materials into toilet pits could be addressed by educating users on the effects of the act and enforcement of sanitation bye laws. The cost of desludging (either manual or mechanical) was not fixed as it depended on the location of the toilet relative to the disposal site, difficulty of sludge removal and the volume of the truck. The trucks usually used for the mechanical desludging had a capacity of 5–8 cubic meters.

With regards to the treatment of FS, respondents preferred to use chemicals, particularly dichlorodiphenyltrichloroethane (commonly referred to as DDT) and calcium carbide which they claim reduce sludge volume, thus reducing the filling up rate and extending the life of the pit. According to Bakare *et al.* (2010), there is a lack of theoretical evidence for the efficacy of chemical additives for the treatment of sludge although respondents claim that their experience in the field has proven their worth. The use of chemical additives, however, affects a wide range of naturally occurring bacteria which feed on the FS thereby slowing the rate of sludge decomposition. A meaningful research into the performance of toilet additives is needed to inform its users.

CONCLUSIONS

The study revealed poor FSM in the peri-urban and rural areas. FS in the peri-urban areas is relatively better managed than in the rural areas. However, there is a need to improve FS in both the peri-urban and the rural areas.

There are no arrangements in place to manage FS completely at the district level. There are no designated locations for disposal and treatment of FS in the study district for the treatment of sludge from septic tanks and pit latrines. For the household toilet, the FSM practice is as follows: households desludge their toilet with cesspit emptiers and transport it to the final disposal site in Kumasi, an average 40 km from the study areas. The few peri-urban respondents who desludge their toilets (3.7% with household toilets) use

WCs with a septic tank. The respondents using dry sanitation technologies try to postpone desludging by adding chemical additives such as dichlorodiphenyltrichloroethane and calcium carbide.

To address the poor FSM situation in the study communities, a decentralized FS composting is a potential technology that could be used. This method of treatment will be beneficial as the majority of the respondents reported that they are willing to re-use FS for agriculture. The study recommends research on the characteristics of FS generated which will be useful for the design of this potential technology, decentralized composting system.

ACKNOWLEDGEMENTS

The authors would like to gratefully acknowledge the assembly men, WSMT and the public toilet attendants of the study communities for their kind help. Thanks to Chris, Michael, Mark, Bernard, Barbara and Solomon for helping in the data collection. This study was financially supported by the SMART Sanitation Project by Bill and Melinda Gates Foundation.

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First received 26 September 2013; accepted in revised form 21 January 2014. Available online 27 March 2014