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## Knowledge, Attitudes and Practices on Use of Fossa Alternas and Double Vault Urine Diverting Dry (DVUDD) Latrines in Malawi

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### ABSTRACT

Fossa Alternas and Double Vault Urine Diverting Dry (DVUDD) latrines have been extensively promoted as ecological sanitation (EcoSan) latrine options in Malawi but little is known about whether they are used properly. A qualitative study of EcoSan users was conducted in Blantyre and Chikwawa districts, Malawi. Data was collected using in-depth interviews (IDI). Twenty-eight (28) and seventeen (17) IDIs were conducted with household heads that had Fossa Alternas and DVUDD latrines respectively. Recorded data was transcribed verbatim and analysed thematically. Of the total 45 EcoSan users; 40 had moderate to high knowledge on EcoSan latrine use, 4 had low knowledge and only 1 had no knowledge on how EcoSan latrines operate. Blockages of urine diversion systems, intensive management and maintenance needed for the latrines were reported as some problems related to the negative attitudes about EcoSan use. Use of soil and ash, urine diverting, use of hot water and chemicals to kill maggots, urinating in the drop-hole of the DVUDDs and poor maintenance of roof were some of the practices reported on use of these latrines. It is therefore recommended that government through community workers should be monitoring practices on EcoSan latrines use and provide necessary support to users.

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4 **Keywords:** Ecological Sanitation, Malawi, practices, double vault urine diverting dry  
5 latrine and Fossa Alterna  
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## 10 **INTRODUCTION**

11 It was estimated that about 1.5 million deaths globally were caused by diarrhoea and this  
12 accounted for 2.7% of all deaths (WHO 2014). In addition, 24% of the world's population  
13 was infected by soil-transmitted helminths (WHO 2015). These diseases may be reduced  
14 through use of improved sanitation, provision of safe water supply, and hygienic practices  
15 (Moore et al. 2001; Bartram et al. 2005). There are a wide variety of sanitation options  
16 available and suitability varies by location and depends on affordability. Environmentalists  
17 promote the use of ecological sanitation (EcoSan) because of its advantages such as;  
18 nutrient recovery and reuse, conserving the environment and minimization of hygienic risks.  
19 Furthermore, these latrine technologies range from those aimed at natural wastewater  
20 treatment to technologies that aim at reusing urine and faecal sludge (Langergraber and  
21 Muellegger 2005). Fossa Alternas and double vault urine diverting dry (DVUDD) latrines  
22 are among the types of ecological sanitation (EcoSan) latrines that aim to recycle excreted  
23 nutrients into agriculture (Esrey 2001). The DVUDD, unlike the Fossa Alterna, is raised off  
24 the ground and has a urine diverting toilet pan that leads to a soak-away just outside the  
25 latrine (Morgan 2007). In other areas of the country and elsewhere, urine is diverted to a  
26 tank where it is later diluted and used in the fields (P. Morgan and Mekonnen 2013). The  
27 Fossa Alterna's pits are dug up to 1.5 metres deep and are lined with bricks. Once the pit is  
28 full, it is sealed and the second is used. When both are full, the first one is emptied so that  
29 the contents can be used while the other one is sealed and allowed to decompose. It takes a  
30 minimum of six months for the contents to be harvested after sealing a pit. The harvested  
31 sludge is used in agriculture. Both DVUDD and Fossa Alterna are also advantageous as they  
32 prevent ground water pollution because the facilities are either built above the ground or dug  
33 to a maximum of 1.5 meters deep respectively as compared to traditional pit latrines which  
34 may go up to 5 metres deep. In addition to this, they also save land because they are  
35 permanent and reduces the need for building another latrine when full as it is with  
36 traditional pit latrines (Breslin 2002). The latrines are built with two vaults which are used  
37 interchangeably unlike most unlined traditional pit latrines in Malawi which when they are  
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4 full, the owner has to look for another space where to dig and build a new latrine (Morgan  
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6 2010).

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10 Fossa Alternas and DVUDDs have been promoted since 2005 in the areas of Chemusa,  
11 Angelo Govea and Lirangwe (SDI 2015). In Angelo Govea, all 64 houses which people  
12 bought on loan at a subsidized price had DVUDDs. These homes are called “federation  
13 houses” and are named after the organization that provides houses to those who cannot  
14 afford a house at the market price. As of 2015, there were 40 DVUDD latrines still  
15 functional in the area and 24 households had gone back to using pit latrines and flush toilets  
16 (HSA 2015) while in Ng’ombe and Zimola villages about 30 latrines were built in the year  
17 2008 and 23 latrines were still functional. Before EcoSan latrine construction, household  
18 members were trained on how to use them. In addition to this, sanitation promoters were  
19 chosen in each area and trained to continuously offer technical assistance to users. They  
20 were also responsible for assisting those who wanted to have an EcoSan latrine to access  
21 loans. Those interested were asked to assemble required number of bricks and cement bags  
22 for latrine construction. The total cost was approximately K150, 000 (USD 272). The loans  
23 were given at an interest of about 4% per month with a maximum payment period of 2 years  
24 (SDI 2015). Despite the promotion of such latrines, few studies have been done to assess  
25 whether these latrines are used properly. Proper EcoSan latrine use is important as it may  
26 affect safety of the sludge produced (Kumwenda et al. 2014). It has also been reported that  
27 uptake of such latrines is low in Malawi (Chunga 2015). It was therefore important to  
28 explore the knowledge, attitudes and practices on EcoSan latrine use as this may be a  
29 starting point for effective promotion of such technologies.  
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## 47 **METHODS**

### 48 **Study type and area**

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50 We conducted a qualitative descriptive study using a case study design. This was done in the  
51 peri-urban (Angelo Govea, Chemusa) and rural area (Lirangwe) of Blantyre and in the rural  
52 villages of Ng’ombe and Zimola in Chikwawa District, Malawi. Blantyre had both DVUDD  
53 latrines and few Fossa Alternas while Chikwawa had only Fossa Alternas.  
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## Sample size and sampling

The total sample size for the study was 45 household heads; 28 with Fossa Alternas and 17 with DVUDDs (Table 1).

**Table 1: Location, type and number of EcoSan latrines sampled**

District	Location	Location classification	Sample size	Type of EcoSan	Year constructed
Blantyre	Angelo Govea	Peri-urban	8	DVUDD	2005
	Chemusa	Peri-urban	9	DVUDD	2008
	Lirangwe	Rural	5	Fossa Alterna	2010
Chikwawa	Ng'ombe	Rural	17	Fossa Alterna	2008
	Zimola	Rural	6	Fossa Alterna	2008

In Lirangwe, Zimola and Ngombe, all the household heads with working latrines were selected for interviews while in Chemusa and Angelo Govea, household heads were conveniently selected. Volunteers from the area who were actively involved in EcoSan project were asked to assist in identifying the households with the latrines (these volunteers were known locally as sanitation promoters). Latrines were also observed to confirm the reported practices during IDIs. In cases where the head of house was not available, the second most influential person was interviewed. The heads of houses were selected because it was assumed that they had an influence in adopting the latrine technology and were better placed to know the challenges of the latrines. In Chemusa and Angelo Govea, the sample size was determined through thematic saturation. Since there were more than 30 households with DVUDD latrines in each of the two locations, it was not possible to interview all the households hence the method. The interviewer stopped looking for new households when after three consecutive respondents gave no new information after probing.

## Data collection

In-depth interviews (IDIs) were conducted with the household heads using these latrines at the time of survey. In-depth interview (IDI) guide was used to collect data. Also permission was sought to observe the latrine after the interview. Data was collected in November and

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4 December, 2014. The interview took place at the respondent's house and took about an  
5 hour. During the interview, a voice recorder was used after obtaining a signed consent from  
6 the respondent and notes were written in a book as a backup.  
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### 10 11 **Ethical considerations**

12 Before the interview and latrine observation started, the interviewer explained the  
13 background and purpose of the investigation and the respondent was given time to ask  
14 questions. The respondent was also assured of confidentiality of information provided. The  
15 ethical protocol approved by University of Malawi, College of Medicine Research Ethics  
16 Committee (COMREC) was followed. The COMREC approval (P.04/14/1565) for the study  
17 was obtained in October 2014.  
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### 26 **Data analysis**

27 Recorded data was transcribed by two independent people verbatim in the local language  
28 (Chichewa) and translated to English before being entered in NVIVO 10 for analysis.  
29 Themes were created after going through the transcripts and field notes. These themes were  
30 coded as nodes and new nodes discovered during repeated readings of transcripts were also  
31 added.  
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39 In order to measure knowledge, attitudes and practices related to the use of EcoSan, we  
40 defined criteria for measurement. Knowledge was defined as information or a skill that one  
41 gains through awareness or experience. An incorrect or correct answer is often used as a  
42 measure that a person does not know something (Hunt 2003). In this study knowledge was  
43 measured by asking respondents to describe the steps followed when using EcoSan latrine.  
44 The explanation was assessed based on how correct the procedures were described and also  
45 if all the steps were explained. If a respondent mentioned all six important steps including  
46 knowledge of things that are not supposed to be disposed of in the EcoSan latrine, he/she  
47 was classified as having a high knowledge on use. Those who mentioned the steps  
48 correctly, but who did not have a knowledge of prohibited items were classified as having  
49 moderate knowledge, and those who also missed some of the steps were classified as having  
50 low knowledge while those who knew nothing were classified as having no knowledge. The  
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steps in EcoSan use that respondents were supposed to know were the ones taught by the sanitation promoters and officers from the implementing NGOs. These included the removal of drop-hole cover and use of footrests, being able to divert urine for the DVUDD latrine, urinating in the drop hole for Fossa Alterna, using decomposable anal cleaning materials, using ash and soil after use, not disposing water in the latrine and safety during the harvesting of sludge. We referred to attitude as one's positive or negative judgment about a concrete subject. Attitudes were measured indirectly using an interpretive technique. Respondents were asked how they feel about the latrine they were using and also about what other people say about it. The answers given were analyzed and interpreted as having a positive, negative or neutral attitude. On the other hand, practices were identified by analyzing how each household used an EcoSan latrine and also from their explanations on challenges and problems faced during EcoSan use and how they solved them.

## RESULTS

### Demographic characteristics of respondents

Of the total respondents (45), 42% were males and 58% were females. Most respondents were females because men were not available during the time of survey. In the peri-urban areas of Blantyre, they were either at work or doing business. About 47% had attended primary education, 33% had attended secondary education while none had done tertiary education. The age range was from 20 to 78 years.

### Knowledge on EcoSan latrine use

Of the 28 respondents using Fossa Alterna and DVUDD latrines; 50% and 65% respectively had high knowledge on how the latrine operates while only one respondent out of all the respondents had no knowledge on how the latrine works and this was because the respondent was not aware of type of latrine being used (Table 2).

**Table 2: Knowledge levels on use of Fossa Alterna and DVUDD latrines**

Knowledge Rating	Respondents with Fossa Alternas	Respondents with DVUDD latrines
High	14 (50%)	11 (65%)
Moderate	9 (32%)	5 (29%)
Low	4 (14%)	1 (6%)
None	1 (4%)	0 (0%)

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6 The sanitation promoters said that during the project phase in 2008 to 2012, they had  
7 constant awareness campaigns and visits by officials from implementing NGOs and Health  
8 Surveillance Assistants (HSAs) but these stopped. This might be one of the reasons why  
9 about half of the respondents had moderate to low knowledge on use of EcoSan latrines. It  
10 was also reported that after the project phased out, the HSAs concentration on EcoSan  
11 latrines was reduced and not included in their daily work as quoted from one of the  
12 respondents:  
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21 “.....it’s good that you have come to remind us about some of the things that we should  
22 follow. The officers who used to remind us about how to take care of our latrines stopped  
23 coming and the HSAs no longer talk about our latrines anymore.” Male respondent,  
24 Lirangwe  
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30 On how the latrines are used, there was no difference in numbers between those using Fossa  
31 Alternas and those using DVUDDs except for the urine diversion. Respondents indicated  
32 that they squat over the drop hole while stepping on raised footrests, if available. After  
33 defaecation, users drop ash and soil through the hole though is often forgotten especially by  
34 visitors and children. All 44 respondents with at least some EcoSan knowledge agreed that  
35 they immediately apply ash and soil when they notice that someone has not applied after  
36 using. Below are the quotes from respondent on use of ash and soil:  
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44 “....it happens, so when one forgets, we pour in the ash and soil. We also pour it in the  
45 evening because nobody else goes in there so we do this so that it mixes up properly.”  
46 Female respondent, Angelo Govea  
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51 “If we suspect that someone has not followed direction, especially visitors and children, we  
52 follow up and pour in ash and soil.” Female respondent, Ng’ombe Village  
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### 57 **Attitudes about use of EcoSan latrines**

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4 While 91% (41) had both positive and negative stories about these latrines; 11% (3) of  
5 household heads with Fossa Alternata and 6% (1) with DVUDD latrine failed to find any  
6 positive in their use of the latrine. The feeling of being disgusted to handle human faecal  
7 sludge and eat the crops fertilized by the sludge, the latrine being labour intensive to use and  
8 blockage of the urine diverting system for DVUDDs latrines were the main concerns  
9 relating to the negative attitude towards these latrines. The blockage in the urine diversion  
10 pipe for DVUDD latrines was due to the improper use of soil and ash which ended up in the  
11 diversion pipe. The other problem was concerning the maggots that crawled out of the  
12 latrines, especially during the rainy season. This problem was reported by 25% (7)  
13 respondents with Fossa Alternata and 12% (2) with DVUDD latrines. The reported  
14 advantages of EcoSan latrines included; source of human faecal sludge, saving land and not  
15 producing bad smells. Respondents indicated that unlike traditional latrines which collapse  
16 within few years, the EcoSan latrines can be used for many years without the need of  
17 digging another latrine. Overall, 73% (33) of the respondents had positive perception on use  
18 of the sludge in agriculture fields. The others were not sure whether it is right to use the  
19 sludge in agricultural fields especially for growing vegetables as evident in the following  
20 quotes:  
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37 *“Those without EcoSan say it’s unhygienic and they would not eat our maize grown with the*  
38 *manure which I feel is safe, but I do not believe it’s safe to use the manure in vegetables*  
39 *because it takes few days before you start harvesting unlike maize. I cannot eat such*  
40 *vegetables but maybe we eat unknowingly.”* A female respondent, Chemusa  
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46 *“We tell others who say that EcoSan latrine and their sludge is disgusting that they say this*  
47 *because they have not benefited from it. But look at us; we have tomatoes, vegetables,*  
48 *because of the sludge from this latrine (EcoSan). They say they were disgusted but then*  
49 *when you harvest manure, they ask, share me a little I should apply in my nursery too.”*  
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54 Female respondent, Lirangwe  
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4 It was also evident that EcoSan users had an attitude towards the latrines from what other  
5 people say as evident from 11% (3) of respondents with Fossa Alterna and 29% (5) using  
6 DVUDD latrines. Below is the quote from one respondent:  
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11 “.....people talk, because they do not know, for example when we moved in this house, they  
12 would say we defecate in pails, they said there would be cholera in our household but up to  
13 now (from 2010) no one has ever suffered from cholera or other diseases. Now people from  
14 other places have started admiring this latrine.” Female respondent, Angelo Govea  
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21 In terms of respondents’ attitudes towards owning an EcoSan, respondents using a Fossa  
22 Alterna saw themselves as better off because they were able to pay back the loan and used  
23 cement for building the latrine as compared to the majority of households who were using  
24 traditional pit latrines built using local materials and could not afford a Fossa Alterna. This  
25 was why these latrines were called “*zimbudzi za makono*” meaning “modern latrines”. In  
26 the peri urban areas of Blantyre, people use pit latrines with concrete floors and iron roofs  
27 which are not different to the DVUDD latrine. Therefore, respondents did not see  
28 themselves as better off.  
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37 On the relationship between use of EcoSan and the risk of diseases, 16% (7) of respondents  
38 thought there is a risk of contracting diseases through handling of faecal sludge while 20%  
39 (9) of the respondents were sure that the sludge was safe. The remaining 64% (29) were not  
40 sure whether they are safe or not. Below are some quotes from some respondents:  
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46 “No, if there were some, we could be sick by now. It’s not that bad as it seems. We just wear  
47 plastics for the sake of cleanliness. The white people were touching it with bare hands. It’s  
48 not harmful.” Male respondent, Zimola village  
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53 “No. Look some of it (manure) is there...right there, if they had pathogens kids would not  
54 play on it, it’s only urine that usually has pathogens and that’s why we divert it to prevent  
55 pathogens so that the manure is safe.” Female respondent, Angelo Govea  
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4 Below is a one of the quotes from those who were aware of the risk that EcoSan sludge can  
5 have if harvested early and not well taken care of:  
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10 *“For the manure, if it is harvested earlier, that is before six months, it can have some*  
11 *germs. ....after harvesting, we keep the manure in direct sunlight for a day or two to reduce*  
12 *‘power’ which may kill our plants. As for worms, people here receive drugs every year from*  
13 *officers who came from Ministry of Health (Chikwawa District Health Office) to visit us.”*  
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16 Female respondent, Zimola village  
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20 Respondents also indicated that after harvesting, you need to put the sludge in the open  
21 under direct sunlight before it can be applied in crops. The reason given was to reduce  
22 fertilizer value. They believed that the sludge had very high fertilizer value which could kill  
23 the plants if applied directly. Though there was no evidence for the reason given, keeping  
24 the manure in direct sunlight has been found to reduce helminths in the sludge. Solar or  
25 ultraviolet radiation reduces and affects the survival rates of pathogens in sludge that is  
26 applied in the field with direct sunlight (Redlinger et al. 2001; Schönning et al. 2004). The  
27 respondents quoted above were advised by the implementing NGO to leave the sludge in the  
28 direct sunlight for at least a week before packing it in bags or transporting it to the field for  
29 use.  
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#### 40 **Perceived benefits for EcoSan**

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42 Users of both Fossa Alternas and DVUDD latrines indicated the following as benefits for  
43 using the latrines: source of human faecal sludge for use in gardens and or for sale, the  
44 latrines not producing bad smell due to use of ash and soil, the latrines do not collapse  
45 during the rainy season and since they act as permanent latrines, they save land. It was  
46 however, noted that the perceived benefits were not the same in both urban and rural areas;  
47 for example, the manure benefit was more common in Fossa Alternas users residing in rural  
48 areas. Also common in rural areas was the reduction of smell in the latrine and the latrines  
49 not collapsing during rainy season. For those using DVUDD latrines in peri urban areas,  
50 their main beneficial factors were saving space, reduced bad smell and also not collapsing  
51 during rainy season. These latrines were built either by using the loans given by  
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4 implementing NGOs or by the NGOs as a demonstration. No new household built the latrine  
5 after the project phased out despite the many benefits experienced by users of EcoSan.  
6 Despite these many reasons, all respondents agreed that they could build latrines with the  
7 help of loans or the latrines would have to be free (i.e. built by NGOs). In Angelo Govea,  
8 the implementing NGO had a policy that every house in their area should have EcoSan  
9 latrine. In Chemusa, respondents said that the DVUDD latrines were also promoted by an  
10 NGO where households were given loans. In Lirangwe, the EcoSan toilets were built as  
11 demonstration units for selected strategic households. Quotes below are evident of what  
12 respondents said on how EcoSan latrines were built in their area:  
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22 “*They [NGO] is the one who taught us to be building these latrines, they gave loans to*  
23 *people if they wanted to build an EcoSan latrine. I can say the advantages are that it does*  
24 *not smell and we harvest manure.*” Female respondent, Angelo Govea  
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29 “*After they left [NGO officials], some people showed interest in EcoSan latrines but no one*  
30 *built it because they do not have money to buy cement.*” Male respondent, Lirangwe  
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35 In Chikwawa, Zimola and Ng’ombe villages, the implementing NGO engaged chiefs and  
36 village management and encouraged every member of the village to have a latrine-  
37 preferably EcoSan. Those without any form of latrine were fined approximately 1 USD if  
38 found using someone else’s latrine  
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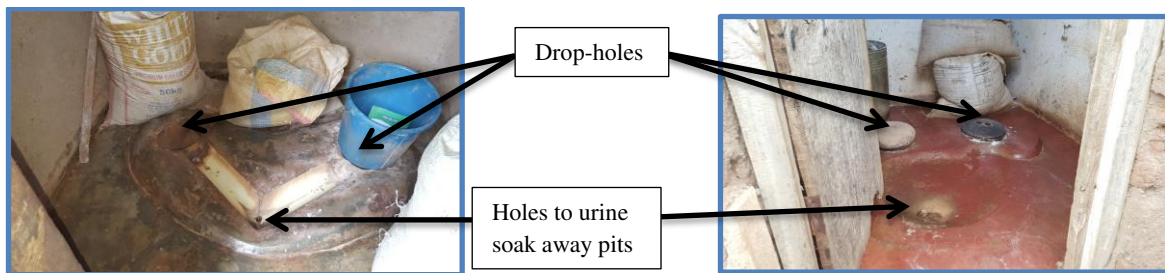
#### 44 **Reported practices on use of DVUDDs and Fossa Alternas**

45 After defaecation, a minimum of one cup of ash and two cups of soil were poured in the  
46 latrine drop-hole. Some households pre-mixed ash and soil while others preferred putting  
47 them in separate containers. The respondents reported that soil and ash helped to desiccate  
48 faeces and reduce smells and moisture, make the pit/vault contents less compact and leave it  
49 less unsightly for the next user. In terms of how much ash and soil to use after defaecation,  
50 about 9% (4) of respondents said they determine the number of cups of ash and soil mixture  
51 to pour in by estimating the amount and type of faecal matter dropped in the pit/vault. Some  
52 quotes below give evidence on how ash and soil is used:  
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6 “We take 3 cups full of ash and soil mixture but if its normal faeces, we use one cup. We  
7 premix...they (women) are told to mix...one pail of 5 litres ash and 2 of soil.” Male  
8 respondent, Zimola  
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13 “.....we take the buckets of ash and soil outside because there is no roof there. In case  
14 rains come it might get wet so we keep them inside the house. We ask men to fix the roof, but  
15 other men are lazy, they always say they are tired so right now I have fetched grass to fix  
16 the roof myself.” Female respondent, Zimola village  
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22 In some situations, the use of ash and soil led to blockage of the urine diversion pipe. Some  
23 children defecated on the urine diversion pipe. Three households reported that their urine  
24 diversion pipe had a small diameter which easily got blocked and caused the urine to  
25 overflow and spill into the drop hole. The drainage system is shown in Photos 1 and 2. The  
26 photos also show the bags of ash and soil stored inside the latrines.  
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43 Photo 1: DVUDD latrine floor

44 Photo 2: DVUDD latrine floor

45 Photos 1 and 2: DVUDD latrines' floors showing urine diversion system  
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### 49 **Materials thrown in EcoSan latrine**

50 Almost all the respondents 98% (44) knew the materials that are supposed to be deposited in  
51 EcoSan latrine and also those that are restricted. The materials used for anal cleansing were  
52 toilet papers, leaves, maize cobs and loose soil lumps. Some cow dung, food leftovers and  
53 chicken droppings were also thrown in the pit/vault because they are able to decompose.  
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58 Two Muslim families using Fossa Alternas in Ng'ombe village said that although they are  
59 supposed to use water for anal cleansing, they cannot use it because water is not allowed in  
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4 EcoSan latrines. Instead, they agreed to be using the bathing room for anal cleansing after  
5 defecation in the latrine. On the other hand all respondents indicated that during the time  
6 they were using ordinary pit latrines; they used to throw in things like broken glasses, worn  
7 out clothes, plastic papers, used water, dead snakes and everything which was not to be seen  
8 by people. About 98% of the respondents also agreed that most of the time people do not  
9 follow what is required; they throw in waste water, papers and other things that are not  
10 decomposable.  
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### 19 **Reported practices during urination**

20 Urine management is different between DVUDDs and Fossa Alternas. For the DVUDDs  
21 visited in Blantyre, urine is diverted to a soak away pit together with water from a bathing  
22 room. The DVUDD relies on desiccation to sanitize the vault contents, which is only  
23 possible when the urine is diverted. Unlike the DVUDD, the Fossa Alterna does not have  
24 urine diversion: all faeces and urine go into the same pit. Sanitization relies on the ammonia  
25 produced from urine, an increased pH due to the addition of ash, and heat. However, these  
26 processes do not happen properly because people don't follow proper practices. For  
27 example, 24% (4) of respondents using a DVUDD in Angelo Govea and Chemusa areas,  
28 reported that some members of their household occasionally urinate in the vault where  
29 faeces go because of laziness and also because they do not want to see their urine, especially  
30 when the diversion system is not working well. Those using Fossa Alternas have a habit of  
31 urinating in the bathing room and not in the latrine. All the respondents using a Fossa  
32 Alterna reported that most members of their households, including themselves urinate in the  
33 bathing room or the bush. The reason was that it was common knowledge that if one wants  
34 to urinate i.e. a visitor, he or she has to be directed to the bathing room unless he or she  
35 specifies that he or she wants to defecate. As for those using DVUDDs, only one user in  
36 Chemusa and one from Angelo Govea reported using the bathing room for urination. They  
37 reported that they avoided urinating in the latrine because urine smells badly especially  
38 when the urine diversion system blocks. Below are some quotes that came out:  
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4 “*The rightful place is the* bathing room or the bush because urine wets the latrine and  
5 makes it collapse faster, also because urine is the one that creates the smell. Urine also  
6 destroys the bricks in the pit.” Female respondent, Zimola village  
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11 “*When a visitor comes we show them a* bathing room. *We don’t urinate here in the latrine.*  
12 But if you want to urinate here, urine goes outside through the drainage pipe to soak-away  
13 pit and faeces in the hole.” Male respondent, Chemusa  
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### 18 **Teaching visitors and children on use of EcoSan**

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20 Visitors and first time users were supposed to be given some instructions on how to use  
21 EcoSan latrine. The instruction could have helped them to be able to separate urine from  
22 faecal matter if using a DVUDD latrine and on how to use ash and soil for both types of  
23 EcoSan latrines. During this survey, it was observed that explaining the instructions to  
24 visitors depended on the situation and the visitor. The respondents said that they could opt to  
25 leave the person to use the latrine and let one member of the house apply ash and soil later if  
26 it’s a respectable visitor like father-in-law or mother-in-law or someone respectable in  
27 society who does not know about EcoSan, Household members usually use smell and the  
28 presence of house flies to know that ash and soil has not been used. For trespassers,  
29 respondents either check the latrine at intervals or use a lock to prevent entry. Others were  
30 unable to explain how to use an EcoSan latrine to visitors because they were afraid to be  
31 labeled as being “rude”. Some of the issues concerning visitors are evident in the following  
32 quotes:  
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46 “*Maybe* the visitor is rushing. Explaining to them would be like torturing them but  
47 *sometimes we don’t because of shyness especially* with older people. Others would prefer to  
48 assume that the visitor will know by looking at the design. But sometimes visitors have  
49 problems channeling their urine to the drainage pipe or sometimes they urinate in the vault  
50 (for DVUDD latrine) so they need *instructions*.” Female respondent, Angelo Govea.  
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4 “We do not allow people who pass to use the latrine. We lock it because others may be  
5 drunk and misuse it. Urine from the drunken person smells bad.” Male respondent,  
6 Chemusa  
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11 “Here we have two types of latrines, an EcoSan and a traditional pit latrine. All visitors  
12 who do not know how to use EcoSan, we show them traditional pit latrine.” Male  
13 respondent, Chemusa  
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19 Respondents with children between the age of six and ten years indicated that they teach  
20 them how to use the Fossa Alterna or DVUDD latrine. For those with children between 4 to  
21 5 years, they allow them to use the latrine and whenever they finish the elderly members go  
22 in to pour soil and ash while those below four years, defecate outside the latrine and the  
23 guardians are responsible for disposing of the faecal matter in the latrine. In Ng’ombe, a  
24 mother said she advises those below the age of five years to defecate in the bush while  
25 others said they go together with child and assist the child to use the latrine while others  
26 follow no specific order. Problems with children included not being able to separate urine  
27 and faeces defecating and urinating in the sides of drop hole, not putting back the drop hole  
28 cover, not using ash and soil after defecating and defaecating in the urine drainage pipe (for  
29 the DVUDD latrine). For those using the Fossa Alterna the main problems included not  
30 using soil and ash, not putting back the drop hole cover and missing the drop hole when  
31 defaecating. One of the household in Lirangwe had a separate latrine for kids. The quotes  
32 below show some of these sentiments:  
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46 “The kids, we would help. We go in and help the youngest kids but if they go in alone, they  
47 urinate everywhere.” Female respondent, Angelo Govea  
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52 “Children do not manage to separate urine and faeces to the designated places and may not  
53 use ash and soil. So we make sure we go and pour in soil and ash and cover the lid.”  
54 Female respondent, Angelo Govea  
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59 “When a child goes in and is not followed up by an elderly person, the child may pour in the  
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4 vault all the soil and ash and also may cause blockage because they even throw in some ash  
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6 *and soil in the drainage pipe.*” Male respondent, Chemusa  
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### 10 **Reported practices when harvesting human faecal sludge**

11 About 62% (28) of the respondents were aware of requirements like wearing of gloves,  
12 using a shovel and wearing boots. Regardless having this knowledge most of them  
13 especially those with fossa Alterna where the person harvesting enters the pit/vault did not  
14 have the required materials to use when harvesting. The other 13% (6) of respondents  
15 thought that since the sludge is from their faeces and that it has been sanitized, there is no  
16 problem touching it with bare hands and they thought that there is no risk of disease because  
17 the sludge looks just like soil. One respondent in Ng’ombe village had all the required  
18 materials like gloves, a shovel and boots that were given by the implementing NGO.  
19 However, since time had passed from the time the materials were given, other respondents  
20 didn’t know if these materials still existed in their area. Only 3 neighbouring respondents  
21 said they were still borrowing these materials. The other 2 respondents from same village  
22 said they relied on hand washing with soap and bathing after harvesting the sludge. They  
23 believed that the germs in human faecal sludge have been washed away during the waiting  
24 period. Below are quotes showing knowledge of best practices during harvesting:  
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39 “We are supposed to have gloves but because of our financial position we just remove the  
40 manure without any protection. But during sensitization, they [NGO officials] told us to be  
41 using gloves when removing manure. *The manure is dry and since it’s ours, we just touch it*  
42 *without gloves, it doesn’t disgust us, .....it’s pure soil and not faeces.*” Male respondent,  
43 Chemusa  
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50 “*We open the vault and remove manure with a shovel...you stand from outside and remove*  
51 *it using the shovel. You also use gloves, mask and gumboots, if you don’t have these you use*  
52 *alternatives like plastic papers as gloves and a cloth as a mask.*” Female respondent,  
53 Angelo Govea  
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59 “*We bathe after removing the manure. We do not wear any protective wear. We bath*  
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4 *because we have touched bad things.*” Male respondent, Zimola village  
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8 *“...people were afraid that this would give them an infection so they thought of mouth*  
9 *covering. We also use a shovel and gloves...we borrow them from the health worker; when*  
10 *he has, he shares.*” Male respondent, Ng’ombe village  
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### 15 **Problems and challenges faced when using EcoSan**

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17 The main problems in rural areas for EcoSan users were the leaking of roofs, the lack of  
18 materials to maintain or re-roof the latrines and the rapid filling rates. The fast filling rates  
19 of the pit/vault led to the removal of sludge before 6 months. Big families with more than 10  
20 people indicated that it took them 3 to 4 months to fill the pit/vault. The other challenges  
21 were a lack of bags for storing the faecal sludge and a lack of buyers for the sludge. The  
22 implementing NGOs promised people that they would find customers for the faecal sludge  
23 but supplies were small in the initial phase and this scared away potential buyers. For those  
24 in Chemusa and Angelo Govea, finding a tenant who is well conversant with use of latrine  
25 was a challenge. In addition, lack of land where they can grow crops and use the sludge  
26 from latrines was another challenge. Those without gardens were disposing of the sludge  
27 just as they would do with solid waste.  
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## 39 **DISCUSSION**

### 40 **Knowledge on EcoSan use**

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42 The respondents had moderate to high knowledge except for 4 who had low knowledge  
43 while 1 respondent did not have any knowledge at all. The low knowledge was because the  
44 respondents were not there during the awareness campaigns either because they had  
45 temporary job elsewhere or they just came in to rent a house with EcoSan latrine. For the  
46 one without any knowledge, it was because the land lord (the owner of house) did not  
47 inform the new tenant about the type of latrine and the tenant assumed it was the usual  
48 traditional pit latrine. In general, respondents thought that their knowledge had declined  
49 because they were struggling to remember some things that they were taught by officials  
50 during the project time. The perceived drop in knowledge levels by respondents could be  
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4 attributed to the phasing out of the projects and lack of support from government field  
5 officers.  
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### 10 11 12 **Attitudes of people on EcoSan use**

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15 Though most respondents (41) had positive sentiments on use of EcoSan latrines, some (4)  
16 with EcoSan had only negative attitudes towards latrine use and its faecal sludge. Some  
17 respondents indicated that they cannot eat food fertilized by EcoSan sludge because they  
18 think it is contaminated with faecal matter. Those with positive attitudes in Blantyre liked  
19 the EcoSan because it saves space while those in Chikwawa said the latrines do not collapse  
20 during the rainy season and are a source of faecal sludge for crops. In Indonesia, the main  
21 driver for EcoSan use was source of sludge (Albrecht, Blackett, and Arianto 2010). In  
22 Tanzania, people accepted EcoSan latrines because of the permanency, durability,  
23 environmental friendliness and fertilizer value (Shayo 2003) while in other areas fertilizer  
24 value is not a major driver because the faecal sludge is in small quantities and some latrine  
25 owners do not have gardens (Drangert and Stockholm Environment Institute 2004; Okem et  
26 al. 2013). This means that people prefer EcoSan latrines not mainly as a means of sanitation  
27 but because of other associated benefits. The negative issues about EcoSan use were mainly  
28 influenced by what other people who do not have the latrines said. The main issue was the  
29 feeling of disgusted because they imagined that the faecal sludge was in the crops they  
30 produced. Furthermore, lack of technical skills to address a problem with the latrine i.e.  
31 blockage of pipe, drainage problems, led to the development of negative attitudes about the  
32 latrines. Negative attitudes were also found in other studies which showed that some people  
33 think crops fertilized with faecal matter to grow and faeces are also in the food (Nawab et al.  
34 2006). In another study done in South Africa, it was found that attitudes towards handling of  
35 faecal matter were strong. However, people showed openness to changing their minds  
36 (Duncker et al. 2007). While other studies reported cultural issues (Nawab et al. 2006), this  
37 study found no cultural issues related to EcoSan. Most respondents were of low economic  
38 status earning an average of 36 USDs per month and mostly used unimproved traditional pit  
39 latrines previously. This made them view a Fossa Alterna or a DVUDD latrine as an  
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4 improvement from the ordinary latrine, which is built using local materials. For those in  
5 rural areas, the EcoSan latrine is an improvement in their lives because it is built using  
6 bricks and cement. This confirms that sanitation needs also follow a Maslow's hierarchy of  
7 needs where once a need is satisfied, a higher need emerges (Dellström Rosenquist 2005).  
8 While this study reported that the main barriers for DVUDD latrines were financial  
9 resources, attitudes and lack of gardens where to apply faecal sludge, others studies found  
10 similar barriers (Rajbhandari 2008; Uddin et al. 2014; Keraita et al. 2013). The cost of  
11 EcoSan is lowest in Southern Africa estimated at USD 350 (Mara 2008).. The sociocultural  
12 issues about reuse of sludge from human excreta and the practice of urine diversion also  
13 influenced the attitudes towards FA and DVUDD latrines by users as they referred to what  
14 other members of the society say about their latrines. According to a study on knowledge,  
15 attitudes and practices on oral health in the children, the sociocultural environment was an  
16 important factor in development of an attitude (Smyth, Caamaño, and Fernández-Riveiro  
17 2007).

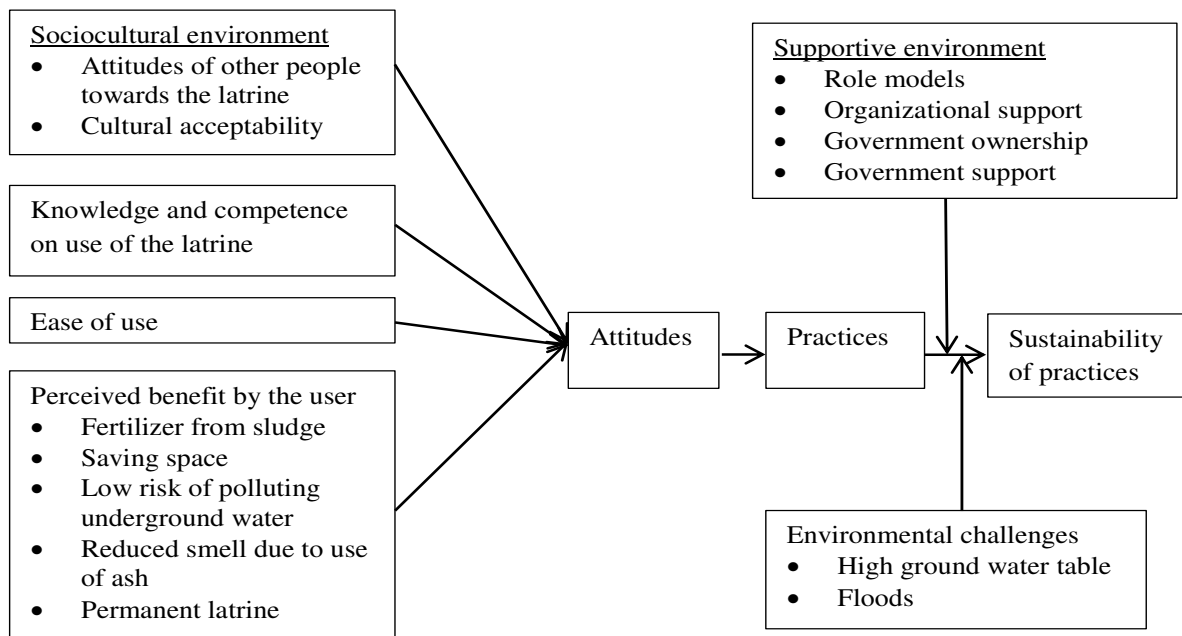
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32 In Zimola and Ng'ombe, the EcoSan latrines were introduced in 2008; people still see  
33 latrine technology as new. For users to completely get used to the technology and change  
34 their attitudes, they need enough time to go through stages of behaviour change (Prochaska  
35 and Velicer 1997). EcoSan latrines are mostly introduced in communities through NGOs  
36 who usually have a defined period to work in an area depending on funding. This short  
37 implementation period makes it difficult for communities, especially those slow in adopting  
38 technologies, to be taken through a stage where they start making own initiatives to build  
39 EcoSan latrines. During the time of this survey, the implementing NGOs were no longer  
40 supporting communities in terms of awareness, loans and technical advice. This could also  
41 partly explain why no household made own effort to have EcoSan after implementing  
42 NGOs left.

### 53 **EcoSan Practices**

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55 Common unacceptable practices observed included throwing non-biodegradable materials  
56 like stones, metals, glasses and plastic papers into the latrine, not maintaining the roofs,  
57 using chemicals and hot water, urinating in the latrine drop hole for those using DVUDD  
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4 latrine and urinating in the bathing room or bush for those in rural areas and using DVUDD  
5 latrines. Practices like using chemicals and hot water were done to abate effects of improper  
6 latrine use like smell and maggots. Through observations and discussions, maggots coming  
7 out of the pits/vaults occurred when ash and soil was not used and when water from rain  
8 entered the latrine as runoff or through underground or through leaking roof. These  
9 households with maggot problems reported using hot water, hot ash, battery acid, chlorine  
10 and other chemicals to kill the maggots. In order to make sure there are no maggots, users  
11 were supposed to prevent water entering the vault and use ash and soil as required. For  
12 DVUDD latrines, a lack of proper urine diverting system contributed to the problem.  
13 Urinating in the bathing room for those using a Fossa Alterna reduces urine content which  
14 has fertilizer value and is a source of ammonia which acts as a sanitizer (Jørgen Fidjeland et  
15 al. 2013; J. Fidjeland et al. 2015). As for DVUDD latrines, urinating in vault makes the  
16 contents moist contrary to the aim of DVUDD which is to make the sludge dry. Different  
17 practices may affect human faecal sludge quality and pathogen die-off rate. Practices  
18 especially disposing of waste water and failure to make the latrine pits/vaults water tight  
19 make the pits/vaults to be filled with water and promote the multiplication of maggots. It  
20 was also noted that while respondents used to throw anything in ordinary pit latrines, they  
21 now know that not everything can be deposited in an EcoSan latrine. This was similar with  
22 other studies where they also found that people just throw anything in an ordinary pit latrine  
23 and this contributes to quick fill-up and problems in emptying (Bakare et al. 2012).  
24 Problems with latrine use has also been reported in other studies involving urine diversion  
25 latrines, they have suggested using urine pipe of about 75mm in diameter and a gradient of  
26 at least 1% for effective urine separation (Jönsson and Vinnerås 2007). This study observed  
27 that most urine diversion pipes were small with diameters of less than 50mm. other  
28 households used electrical tubing pipes for urine diversion because they are cheap. Though  
29 the knowledge levels do not always translate to good attitude and proper practice, it is  
30 important as it is the starting point towards achieving a proper practice (Smyth, Caamaño,  
31 and Fernández-Riveiro 2007). The EcoSan users need periodic awareness on because they  
32 meet different technical challenges as they are using the latrines.  
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During harvesting, households were unable to use proper protection mainly because they could not afford buying protective wear like gumboots, and gloves though some utilized local resources like plastic bags. The perception that human faecal sludge is safe contributed to lack of initiative to protect oneself during harvesting of the sludge. Dryness of sludge, lack of smell and seeing children playing on heaps of human faecal sludge made users think it's safe. Similar perception was also found in a study done in Vietnam (Mackie Jensen et al. 2008). The various factors that affect attitudes and subsequently practices in this study have been summarized in the Figure 1. The figure has also incorporated supportive environment and environmental factors as important to sustain a good practice on EcoSan use.



**Figure 1: Factors that were related to practice and sustainability of a practice**

The practices displayed during EcoSan use in Chikwawa and Blantyre in Malawi may be best explained in the model in Figure 1. The sustainability of the practices on use depended on constant monitoring of officials from implementing NGOs and also the trained sanitation promoters and health surveillance assistants. This was found to be temporal due to lack of government support because after the projects phased out, this support system died.

## CONCLUSIONS

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4 Despite some unacceptable EcoSan practices, respondents knew what EcoSan latrines were  
5 and also knew the basic operational principles like urine diversion, the need for soil and ash  
6 and allowing a waiting period before harvesting the sludge from the pit/vault. This means  
7 periodic awareness campaigns on use and maintenance of the latrines would be useful in  
8 maintaining good practices. Most of the poor practices observed were technical in nature  
9 and these needed a competent extension officer to be advising households which faced such  
10 problems. On perceived safety of the sludge, there is need for awareness so that people  
11 should know that their sludge may not be safe. This will assist users of sludge to use  
12 protective wear when harvesting, transporting and applying the sludge in their fields. The  
13 awareness will also help the users of EcoSan sludge to store it in a hygienic manner. In all,  
14 the government through water monitoring assistants and health surveillance assistants  
15 should periodically monitor how EcoSan latrines are used and provide appropriate support  
16 to users especially after the implementing NGOs phase out their projects.  
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## "Knowledge, Attitudes and Practices on Use of Ecological Sanitation Latrines in Malawi"

**Note:** Due to the major changes done, it has been difficult to put changes tracked. This was because most of the paragraphs were completely changed.

### How comments have been addressed

	Comment	How it has been addressed
1.	Editors comment on possibility of focussing on EcoSan users only	This has been changed. All information about those without EcoSan latrines has been removed
<b>REVIEWER #2</b>		
2.	The general topic of the paper is relevant to this journal. And the authors are to be commended for sharing research such as this (knowledge, attitudes, and practices) which are not often published. However, the submission need significant revision before it meets the standard required for publication.	The manuscript has been significantly revised
3.	The most significant revision is to refocus the paper. The title does not match the purpose of the research described in the introduction, and the datasets and analysis also do match the purpose of the research.	The title has been revised to "Knowledge, Attitudes and Practices on Use of Fossa Alternas and Double Vault Urine Diverting Dry (DVUDD) Latrines in Malawi" and purpose has been revised
4.	I would strongly recommend the authors discuss the specific purpose of this paper - the specific research question they will seek to address, and then structure the paper appropriately. The paper needs to be much more focused; there is a large group of authors and discussion together would surely assist this lead author to better focus the paper. Once the research question is clear, include only data relevant to the research question.	This has been re-written as follows: "Despite the promotion of such latrines, few studies have been done to assess whether these latrines are used properly. Proper EcoSan latrine use is important as it may affect safety of the sludge produced (Kumwenda et al. 2014). It has also been reported that uptake of such latrines is low in Malawi (Chunga 2015). It was therefore important to explore the knowledge, attitudes and practices on EcoSan latrine use as this may be a starting point for effective promotion of such technologies."
5.	From reading the introduction, and the detailed description of practices, the purpose seems to be to understand whether (practices), and why (knowledge, attitudes) EcoSan sanitation is being used 'properly'. If this is correct, and the research question to be published is about the proper use of EcoSan, then there is probably little value in including non-users of EcoSan in the data and analysis. A comparison of users and non-users is useful for understanding why some people DO adopt EcoSan and some don't. But if this paper is trying to	It's true. The non-EcoSan users have been excluded

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	understand whether those that have adopted EcoSan are using it properly (and why or why not), then focus only on the data from the users. This would also require focusing on results that relate to understanding whether (and why) EcoSan use is not occurring properly.	
6.	If the paper is going to instead on the comparison of users and non-users, then the focus needs to be on understanding why some people adopt EcoSan and why some don't. This would lessen the data describing practices. I would not recommend the author take this focus, as the methodology does not seem robust for a comparison of users and non-users.	It's on how EcoSan is being used as above
7.	Need more detailed description (list or table) of the types of technologies grouped as "EcoSan".	
8.	Practices - the practices described seemed to be "reported practices" rather than practices observed by the researchers. What is the likelihood that these practices were reported accurately?	The practices were "reported ones" and the probing was used to verify the practices. Probing was done several times to confirm the answers
9.	Non users of EcoSan	Have been removed
<b>REVIEWER #1</b>		
10.	The article is too focused on "describing" rather than "investigating" or trying to understand the causes and implications of the KAP gaps.	Have tried to understand the reasons for knowledge, attitudes and practices
11.	Most problematic is the fact that there is no information given about how the families came to possess the technology, what type of training they were given, or how long ago this training was given (or not given). Depending on the training, the study population could actually be following the directions that they were given. Or, alternatively, the differences could be attributed to the different NGOs that implemented the training, or to the length of time that has elapsed since the training was conducted. These, and other aspects were not adequately investigated. To really understand the root cause of these differences in KAP, more work must be done.	The implementing NGOs have not been revealed because of ethical issues but the way families acquired the latrines has now been explained as follows. They were acquired through loans, some build by NGOs as a demonstration while others especially Fossa Alternas were built by families themselves because they are cheaper
12.	There is not a clearly defined research question and this leads to the construction of a manuscript that is purely descriptive, and that lacks a clear research objective.	The research objective has been refined.
13.	Furthermore, at least 3 different technologies are described and lumped together, despite the fact that they have very different features, other than the fact	They have been split to Fossa Alternas and DVUDD latrines as suggested. The results are for specific types except for a few cases

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	that they operate without water. I am not convinced that these should be combined into a single analysis and would recommend further justification for why they can be considered as a single grouping. Personally, I do not like the label "EcoSan" since it is quite vague, and can include many different types of systems and technologies- worm toilets, single vault UD toilets, double-vault UD toilets, fossa alterna, biogas-based toilet, etc. etc.... I suggest you try describing the technologies that you have chosen in a more concise way or clearly indicating what and how you define EcoSan as.	where it applies to all. EcoSan latrines have been redefined according to the reference given. i.e. "Environmentalists encourage the use of ecological sanitation (EcoSan) because of its advantages which mainly focus on nutrient recovery and reuse, conserving the environment and minimization of hygienic risks. These latrine technologies range from those aimed at natural wastewater treatment to technologies that aim at reusing urine and faecal sludge (Langergraber and Muellegger 2005)"
14.	"Helping" yourself is not a common or necessary euphemism. Urinating, defecating, going to the toilet, or even relieving oneself are better. This is a scientific article and so scientific language should be used- especially when clarifying what product was generated in each technology (e.g. urine or faeces).	This has been revised to "defaecating and urinating"
15.	Abstract: "sequentially" is misleading, since it was not a panel data set	This word has been deleted
16.	Abstract: when you say that the data was "transcribed verbatim": what language was that?	The records were in local language called Chichewa. This has been revised
17.	Abstract: "manure" is not a commonly accepted word for human excreta- faecal sludge, humus, excreta, or another term would be more suitable	In this case, faecal sludge has been used
18.	Abstract: "involving" is quite vague and is a poor word choice- do you mean difficult?	This has been reworded
19.	Abstract: "practices varied..." is unnecessary	This has been deleted
20.	Introduction: P1L46: "significant" is not entirely accurate- or you need to justify this with a value	The word has been deleted
21.	Introduction: P1L49: "water closet toilets" is quite vague- I suggest you elaborate on the differences between waterborne and dry sanitation options	This has been replaced with flush toilets Line 70-71 on page 3
22.	Introduction: P1L51: the definition of EcoSan is not correct- it can take various forms and is not necessarily a "form of pit latrine". It does NOT prevent ground water pollution. This section is quite weak and does not clearly elaborate the points given in Langergraber and Muellegger- the criteria that qualify a technology as being EcoSan should be elaborated- only a few, seemingly random points are highlighted (e.g. space).	We have revised to some EcoSan options and have refined definition and adopted the one given by Langergraber and Muellegger, line 42 to 47 page 2
23.	Introduction: P2L2: There are MANY types of EcoSan toilets. As above. Fossa Alterna is an invention of Peter Morgan and should be referenced. Skyloo is not a commonly used term and should be	This has been taken care of and Fossa alterna has been referenced. Line 46 to 50 page 2

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	replaced with a more common definition.	
24.	Introduction: P2L24: "high" is not clear- what is the value or the limit?	The word "high" has been deleted page 2
25.	Introduction: P2L29: what is meant by "environmental conditions"?	The sentence has been revised on page 2 first paragraph
26.	Introduction: Figure 1: this is a very low quality figure that is difficult to read and should be redone	The figure has been deleted. Figure one is now different
27.	Methods: All of these locations and places are confusing- omit them or include some description about why they are significant.	The places have been well described as rural and urban. Each location had specific type of EcoSan latrines. Line 89 to 93 page 3
28.	Methods: P3L9: this issue of "sequentially" is not correct: it doesn't matter the order that it was done because you didn't return to the same houses. You did the EcoSan at a different time than the non-EcoSan. That is not sequential sampling because they could have been done at the same time.	Yes, that is very true and we have re-written the sentence. Line 100 to 112 on page 4
29.	Methods: P3L24- I am surprised that the work was done in English	The work was done in Chichewa and translated to English. Thanks for noticing. It's on line 131 to 132 on page 5
30.	Methods: P3L31- what is the difference between a concept and criteria? Clarify in general	In this study, a criteria was used which has been defined as a principle or standard on which something can be judged. This has been refined on Lines 137 to 139 page 5
31.	Methods: P3L31: the whole section on Knowledge needs to be addressed: it is very unclear how the scaled worked, how many answers the respondent needed to "pass" (e.g. all of them? 4/6?). Also, as I mentioned above, how do you know that these 6 steps were explained to the user? Maybe they were only taught 5? I really cannot put much weight on the findings without knowing what kind of prior training and information they were given.	The section has been overhauled as suggested
32.	Methods: P3L46: I have similar difficulties with the attitude section: was there only a positive or negative assessment? By asking if someone "liked" something, you are automatically framing it and priming the subject for a positive reply. How the assessment and scale worked to assess attitudes requires much more detail.	The attitudes were derived from what respondents said about EcoSan. The question of liking and disliking was asked at the end as a summary question but did not affect the views already given by respondents. The section has been refined on page 8.
33.	Methods: Figure 2: vertical text is not acceptable. What is a san-plat? There are too many words for a figure-simplify and shorten.	The Table has been deleted. Only descriptions have been used
34.	Table 1: this degree of dis-aggregation is not necessary. Either by area or by descriptor. Far more useful would be to divide the data by toilet TYPE. UNLESS you can dis-aggregate the data by	The data has been disaggregated by latrine type as in the revised Table 1

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	project or implementing NGO. It is of little value to include so many locations with only a few data points from each. What is the reason for including marital status? The age range is also not useful.	
35.	Table 2: as before, how were these categories created and what do they mean? This was not clarified earlier. Furthermore, General: I would like some clarification about how and why the non-EcoSan users were selected and whether or not they were a) offered the EcoSan toilet and refused or b) were not offered the toilet. These are 2 very different groups and are not comparable.	This has been revised
36.	P6L46: Why does it matter that 2 respondents from Chemusa had no positive things to say? These types of numbers and summaries need to be contextualized within the broader numbers- is this a large percentage of people in this area? Of the total sample? I don't have a feeling for what these numbers mean unless you explain them. This is true for all of this section. It is distracting to read the descriptions for each individual area- rather focus on the differences between the EcoSan and non-EcoSan people. The same sizes are too small to be able to view the results from a single area as significant.	This has been revised on page 8. The non-EcoSan users have been removed from the manuscript
37.	General: there is a great deal of discussion about what households do- e.g. hot water, battery acid, but at no point are the "correct" or acceptable behaviours defined. Why these behaviours are "wrong" is also not defined. There are too many vague terms like "properly" "unhygienic", "sometimes" that really do not explain to the reader what is happening in the toilets or the minds of these people	The words have been revised and issues have been discussed as suggested.
38.	General: I do not understand how these toilet "save land" as compared to a pit latrine. Often, UD toilets, especially, or even FA take up much more space than simple pit latrines. Information about the dimensions of the different types of toilets would be very useful.	It's because the two pits can be used interchangeably without digging a new latrine. In Malawi, pit latrines are not emptied in the rural areas. Once it is full, people dig and construct a new one. This has been explained in the manuscript
39.	Currently the information ("loans") is too vague to understand what happened. This information would be best summarized in a table- loan value, fine value, toilet type, installation date, etc.	We have tried to address this by indicating the dates of latrine construction and type. Also the loans have been explained
40.	P7L35: I have never heard about putting the excreta in the sunlight- is this practice that you think is important or have NGOs recommended this?	Literature has shown that sunlight helps to sanitize sludge especially if solar panels are used. We hope the practice may be helpful.

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		This has been clarified.
41.	P8- Motivation: As before, I wonder about the bias present in the sample selection, especially when it comes to motivation. I suspect that these people who have the toilets were the ones who volunteered to have the toilets and are therefore already more motivated.	Yes, these people have EcoSan latrines and they decided to have them after the awareness campaign by NGOs.
42.	P10L13: "hence urine diversion" is not clear	Yes, this has been revised
43.	P8- this first paragraph is very confusing. Separate out the different points because they are mixed together. Furthermore, it is unclear what points the quotations are trying to reinforce- rather separate them so that they reinforce individual points.	This has been separated
44.	Please clarify. Additional information about how the toilet owners got the toilets and how much they had to pay would be essential in understanding if they self-selected into the toilet program.	This has been revised. They got latrines through loans, built by NGOs or themselves for fossa alterna
45.	P10L22: "They do this to prevent urine diversion problems": do what?	They urinate in the bathroom or in the bush. This has been revised
46.	P11 Children and use of EcoSan- as with other sections, there is so much detail but it is difficult to understand what is being said- do the children understand or not?	The subheading has been revised
47.	P12: Discussion- some parts are clear and explain WHY the KAP gaps are as they are, e.g. the landlord did not inform the tenant. Great. But what are the other reasons? This section should be the bulk of the paper, and right now it is a short summary of the results with very little interpretation or analysis. More is needed. Statements like ""high number" or "high knowledge" are too vague and not acceptable.	The section has been revised
48.	P13L28: "This made them view..." is not clear- why?	This has been revised
49.	Figure 3: needs to be clarified and improved. Again, this makes me wonder whether you are comparing EcoSan owners to owners who had the chance to get a toilet or those who never had a chance. Did the non-owners actually reject the EcoSan toilet or were they just not given a loan?	This has been deleted
50.	P14L27: "different practices are not uncommon" is obvious and a weak argument. Conclusions: in reading the conclusions I have no real feeling about the main findings- did most people have an understanding of the EcoSan technology? I also do not have a good understanding about what the reason for including the non-EcoSan people	This has been revised to: Despite some unacceptable EcoSan practices, respondents knew what EcoSan latrines were and also knew the basic operational principles like urine diversion, the need for soil and ash and



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<p>was. I don't think that the conclusions written are actually coming from the findings of the paper.</p>	<p>allowing a waiting period before harvesting the sludge from the pit/vault. This means periodic awareness campaigns on use and maintenance of the latrines would be useful in maintaining good practices. Most of the poor practices observed were technical in nature and these needed a competent extension officer to be advising households which faced such problems. On perceived safety of the sludge, there is need for awareness so that people should know that their sludge may not be safe. This will assist users of sludge to use protective wear when harvesting, transporting and applying the sludge in their fields. The awareness will also help the users of EcoSan sludge to store it in a hygienic manner. In all, the government, through water monitoring assistants and health surveillance assistants should periodically monitor how EcoSan latrines are used and provide appropriate support to users especially after the implementing NGOs phase out their projects.</p>
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