

THE STUDY OF ECOLOGICAL SANITATION SYSTEMS IN DAR-ES-SALAAM (TANZANIA)

By Anesi S. Mahenge

*Waste Stabilization Ponds and Constructed Wetlands Research
Project, P.O Box 35131, COET, University of Dar-es-Salaam, Dar-
es-Salaam, **TANZANIA***

Cell: +255-713-447131

E-mail: anesimahenge@yahoo.com

INTRODUCTION

- Many cities are short of water and subject to critical environmental degradation. The peri-urban areas are among the worst polluted and disease ridden habitats of the world.
- Sewage discharges from centralized waterborne collection systems **pollute surface waters** and seepage from sewers, septic tanks and pit toilets **pollute ground water**. Conventional sanitation technologies based on flush toilets, sewers, treatment and discharge cannot solve the problem in urban areas lacking necessary resources such as water, money and institutional capacity.
- The ecological sanitation is the new approach introduced recently in Tanzania hence it was necessary to study the existing situation and evaluate the performance of the ecosan system in pre-treatment of human-excreta.
- The study on performance of ecosan systems in pre-treatment of human-excreta focus on: reduction of organic matter, rate of production of methane gas (Methanogenic Activity), biodegradability of human faecal material, and reduction of parasites as ***compared to normal pit latrines***. The study also focused on checking the safety associated with reuse of human urine in agriculture.

EXISTING SITUATION ON ECOSAN SYSTEMS IN DAR-ES-SALAAM

Description of the Study Area

- The Study was conducted at Majumbasita and Karakata wards in Dar-es-Salaam. The area are one of the unplanned settlements at the peri-urban part of Dar-es-Salaam City in Tanzania. It is about 11 km. from the city centre and it is closer to the DIA.
- The area has a population of about 23,000 inhabitants
- Houses are mostly occupied by owners, with few inhabited by tenants and the size of one household is 5-7 people.
- The piped water supply from the city network is inadequate for the inhabitants; 85% depend on well water (John, 2001) and are forced to use hand-dug wells although the quality is doubtful (Chaggu *et al.*, 1993; Matto, 2002).
- Mahenge and Chaggu (2002) noted intermittency of water supply per week; that is, supplied for 2-4 hours only per supply. Only 5% of the residents get it once per week, 63.2% two days/week, 28% three days/week, 2% four days/week and 1.8% manage to get water for >4 days/week.
- The underground water table is about 0.5m below the ground-surface.

EXISTING SITUATION ON ECOSAN SYSTEMS IN DAR-ES-SALAAM Cont...

Description on Existing Situation of Ecosan Systems

- There are 95 ecosan toilets built at the study area.
- Almost all people (about 96%) accept the ecosan systems.
- The Ecosan system involves the separation of urine at the source of production using urine separation toilets (pictures 1-7).
- 20 litres containers are used for storage of urine based on the easiness of lifting by one person for emptying purposes.
- For a household of 5-7 people commonly found at the study area, the storage tanks has to be emptied each 3-4 days.
- The urine is presently used as fertiliser in the gardens.
- A handful of charcoal or firewood ash is used as additive in the toilets once per day everyday.

EXISTING SITUATION ON ECOSAN SYSTEMS IN DAR-ES-SALAAM Cont...



Ventilation Pipe

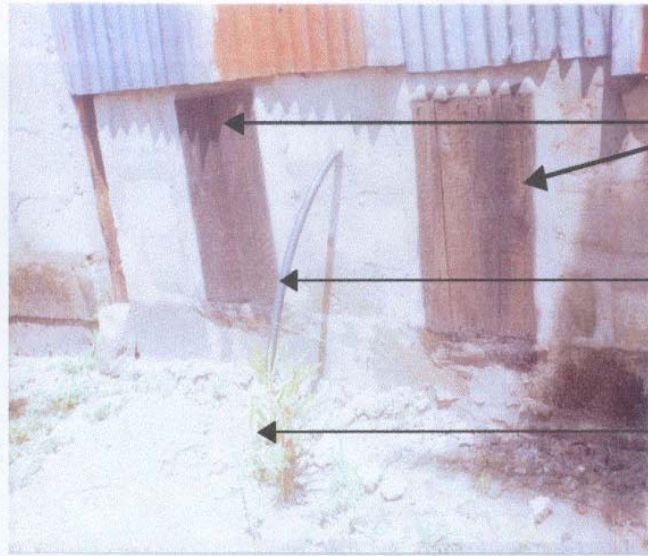
Picture 1: Front View of the toilet.



A: Rear side of the pits

Picture 2: Rear Side of the Toilet

EXISTING SITUATION ON ECOSAN SYSTEMS IN DAR-ES-SALAAM Cont...

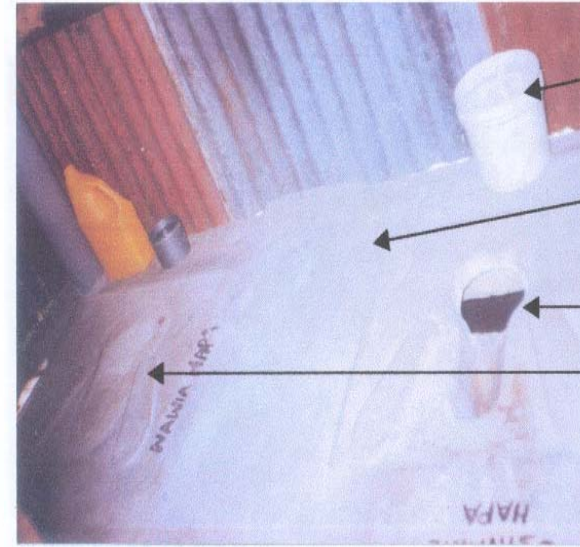


Emptying Doors at the Rear Side of the Pits.

Drain Pipe for conveying Washing and Anal cleaning Water.

Flower.

Picture 3: Detail A - Rear side of the pits.



Charcoal Ashes Inside the Container

Area for washing and anal Cleaning.

B: Squatting pan in use

C: Standby squatting Pan

Picture 4: Inside of the Toilet

EXISTING SITUATION ON ECOSAN SYSTEMS IN DAR-ES-SALAAM Cont...



Picture 5: Detail B: Squatting-Pan



Picture 7: Garden that uses Human Urine as Fertilizer



Picture 6: Urine-Container

The Dimensions and other details of Ecosan system at Karakata and Majumbasita is as presented in **Table 1**.

EXISTING SITUATION ON ECOSAN SYSTEMS IN DAR-ES-SALAAM Cont...

Table 1: The Dimensions of Ecological Sanitation Toilet in Dar-es-Salaam

Component		Dimension (m)			
		Length	Width	Height	Depth
Superstructure	General	2	1.2		-
	Front-View	-	-	2.0	-
	Back-View	-	-	1.7	-
Squatting-Slab (pre-cast)		0.97	0.88		
Floor Slab		2	1.2	-	-
Pit (2.4m ³)		2	1.2	1.0	-
Pit relative to ground-level		-	-	1.0	0*
Openings for removing dehydrated faecal material		0.6	0.45	-	-
Urine and anal cleaning pipe		25cm. (1") PVC at a slope of 1:75 to 1:110			
Vent pipe		100mm. PVC pipe with a plastic cap** with holes on top (protrusion~0.5 m. above the roof cover)			
Angle of foot-rest		30° from normal direction of the foot			
Size of the hole		20cm diameter			
Urine container		20–60 litres (but mostly 20 litres for easy lifting)			

*The table raw data was from EEPKO (2002) *Zero depth indicates that, the pit structure is above ground with an exception of some cm. for foundation.*

MATERIALS AND METHODS

▪ **Materials**

Human faecal material and urine were the samples taken from the ecosan systems for the study.

▪ **Questionnaires**

Questionnaires were conducted with the users of ecosan systems to get information on the existing situation.

▪ **Sampling and Analysis**

- Human faecal materials and urine from 10 ecosan toilets were sampled twice per week for three months.
- 1kg of faecal material and 1 litre of urine were collected per latrine for laboratory analysis.
- The pH was determined both in-situ and in the laboratory.
- Other determined parameters were ambient temperature of the samples (in-situ and the in laboratory), COD, TSS, VSS, Volume of Methane Gas produced, Stability test; all determined using Standard Methods (1992).

RESULTS AND DISCUSSION Cont...

(i) Urine Diversion:–

Urine also contains organic matter with COD concentrations of about 2500 mg/L, so due to its diversion it means decrease of COD in faecal material.

(ii) Additional of ashes in faecal material:–

The ashes they are using contain higher amounts of oxygen in oxide forms, like Calcium Oxides, Magnesium Oxides, Silicate e.t.c. The Oxygen present in Oxide form may be used in Oxidation of organic matter, hence lower COD concentrations in faecal material from ecosan toilets.

RESULTS AND DISCUSSION

Faecal Material Results and Discussion

pH

- The pH results ranged from 6.0-10.4 due to addition of ashes.
- The correlation by ANOVA between pH and age of faecal material is highly significant at $P < 0.001$
- It was furthermore evident that, the pH increases with increasing age of faecal material in the faecal chamber.

Total COD

- Average total COD concentration in faecal material from ecosan toilets and normal pit latrines are 5500 mg/L and 35000 mg/L, respectively (the data are from toilets with 6 months age) .
- The average decrease in total COD is equivalently to 85.
- The lower COD concentrations in faecal material from ecosan toilets could be of the following reasons;

RESULTS AND DISCUSSION Cont...

Ascaris Eggs

- The average number of ascaris eggs in faecal material from ecosan toilets and sludge from normal pit latrines are 280 number/1000gm and 4000 number/1000gm, respectively.
- The % decrease in number of ascaris is equivalent to 91.
- The reduction in number of ascaris is mainly caused by:-
 - (i) Dehydration of faecal material in ecosan toilets caused by urine diversion:—dehydration deprive the moisture that ascaris need to survive hence lower numbers of ascaris in ecosan toilets.
 - (ii) Higher pH values in faecal materials of ecosan toilets:— Higher pH values cause alkaline conditions in the toilets of which it speeds up the death of ascaris and other pathogens.

RESULTS AND DISCUSSION Cont...

Methanogenic Activity (MA)

- MA defines rate of methane gas production.
- Average methanogenic activity in faecal material from ecosan toilets and in sludge from normal pit latrines is 92 mg-COD/g-VSS/day and 201 mg-COD/g-VSS/day, respectively.
- The decrease in rate of methane gas production is equivalent to 31.
- The slower MA in ecosan toilets might be due to lower COD concentration values found in faecal material of these toilets and the alkaline conditions found in faecal material.

RESULTS AND DISCUSSION Cont...

Stability Test

- It takes around 80–100 days and 70 days for the methane gas to stop its production in ecosan toilets and normal pit latrines, respectively.
- Ecosan systems take longer time to stabilize because; much time is consumed in lowering of the pH at the acidogenesis stage.
- Acidogenesis is a second stage in anaerobic decomposition of organic matter. In this stage, the acid formers first become active reducing the pH to below 7 and then they start to decompose the dissolved organic matter present in their cells. Since the faecal materials from ecosan toilets have higher pH about 8.8 and above, then much is consumed to lower the pH.

RESULTS AND DISCUSSION Cont...

Urine Results and Discussion

Faecal-Coliforms

- Approximately 50% of ecosan toilets (10 samples) their urine are contaminated by faeces and the average faecal-coliforms counts were 2780 counts/100 mL urine.
- The other 50% of ecosan toilets were out of the maximum WHO Guidelines for unrestricted reuse in agriculture (1000/100ml.).
- Presence of faecal-coliforms in urine implies continued advocacy on use and separated urine can be re-used in tree growing, not for fertilising food crops consumed raw, but with adequate separation, the “pure” urine is expected to be free of pathogens (Esrey *et al.*, 2001).

RESULTS AND DISCUSSION Cont...

pH

- The assessed pH of the collected urine ranged between 6.27-11.80 (± 1.9501) and the temperature from 26.1-31.7 (± 1) $^{\circ}\text{C}$.
- From the fact that, the urine pH was 6–7 when excreted, but during its storage would raise to between 9-9.4 because of the degradation of urea (Johansson, 2000), the higher values found in our measurements implies that, there is a certain amount of ashes that went into the urine tank.

CONCLUSION

From the information collected, we can draw the following useful conclusions:

- By using the ecosan toilets, such as those installed at the study area, groundwater contamination can be avoided, since they are constructed above ground.
- More information needs to be collected as to the amount of ash(es) to be added to the faecal chamber.
- A complete separation of pure urine seems to be difficult for users as evidenced by faecal-coliforms observed in urine.
- The separated urine can be used directly as fertiliser in tree growing, but not for fertilising food crops that are consumed raw, due to presence of pathogens.

CONCLUSION Cont...

- The extent of biological faecal material stabilization likely is small in view of the prevailing high pH values.
- A lot of urban agriculture needs to be developed in order to enable the reuse of all the collected faecal material and urine. Otherwise, transport for reuse outside the city is necessary.
- *Ascaris* eggs are efficiently removed in ecosan toilets due to high pH.
- Advocacy on the use of ecosan toilets improves the separated urine quality.

**“Thank You for Your
Attention”**

-The End-