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ECOLOGICAL SANITATION TOILETS IN TANZANIA

Abstract

The viability of ecological sanitation (eco-san) toilets in Tanzania has been effected by the construction of 96 ecological sanitation toilets at Majumbasita peri-urban area of Dar es Salaam (Dsm.) City. Main thrust of constructing EcoSan toilets is due to its potential of preventing groundwater pollution. More than 80% of the city residents are using pit-latrines which have a pollution load to groundwater in kg/day of BOD_5 - 15,282; COD - 16,131; Suspended solids - 6,116; Dissolved Solids - 97,857; Total-N - 4,829 and Total-P - 915. The performance of the built latrines is under study at the moment. Issues like socio-cultural factors, gender acceptability, microbiological aspects are followed up closely. Modifications of designs were often done on-site depending on the social needs.

The pilot area has attracted different stakeholders in the areas of water and environmental sanitation. Through the Ministry of Health and City Council, requests have been made for the EcoSan technology to be implemented at a wide range to curb the pollution and outbreak of diseases (like recent cholera). The government responded by launching a campaign to combat the situation at households level, the same principle has been used by the piloted project by putting more attention on single-households on reducing the environmental impact of discharged wastewater and at the same time made it possible to recycle the nutrients. This paper intends therefore to highlight on the experiences of eco-san structures and reuse aspects in peri-urban area of Dar es Salaam in Tanzania.

Key words: ecological sanitation, gender, reuse, peri-urban

Introduction

Ecological sanitation is not a system, which is well known in Tanzania, although part of its applicability might have been tried in some places without using the 'very' terminology. In its loosely defined form by Morgan (1999), ecological sanitation is a system that makes use of human "waste" and turns it into something "useful and valuable", with minimum pollution of the environment. In essence, it consists of using latrines, which are safe and ecologically sound and designed in such a way that the end products can be easily transferred into agriculture or forestry.

The Asian situation is totally different, as excreta have been handled for over a thousand years making the societies faecalphilic (Missaar, 1997). There are even laws about reuse like The Waste Management Law of 1988 in South Korea which stipulates that night-soil must be treated and may not be applied to the land raw (Strauss & Blumenthal, 1990).

Viewing the existing management of human excreta in Tanzania, (Table1) it is clear that, there is a need to opt for reuse of the nutrients embedded in excreta and urine. About 90% of the Tanzanians are using pit-latrines for disposal of their excreta. Furthermore, it is believed that, 10% of the water supplied to the home ends up in pit- latrines.

Table 1: [1]National Coverage of Sanitation Facilities

Sanitation Facility	Mainland	Dar-es-Salaam	Other urban	Rural	Zanzibar
Own Flush toilet	0.9(1.2)	2.6	3.2	0.2	1.1
Shared Flush toilet	0.4(0.5)	0.8	1.5	0.1	0.2
Improved pit latrine	1.3(1.1)	1.9	3.4	0.7	1.3
Traditional pit latrine	84.2(83.5)	92.1	88.8	82.4	41.3
No facility, bush	12.3(12.8)	1.8	2.2	15.7	56.2
Missing/do not know	0.9(0.8)	0.8	0.9	0.9	0.0
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

According to Haskoning & M4Konsult (1989), about 50% of the pollution produced at domestic level per capita per day, was estimated to be received by pit-latrines, and 33% of the original COD remains in the water that infiltrates to groundwater (GW). Similarly, 10% of the SS, 90% of DS, Total-N and Total-P ends up in GW. Pit-latrines have a pollution load to groundwater in kg/day estimated to be BOD_5 - 15,282; COD - 16,131; Suspended solids - 6,116; Dissolved Solids - 97,857; Total-N - 4,829 and Total-P - 915. This shows that, urban groundwater is both an asset and a problem. It is an asset because of its value for water supply for drinking and industrial use. Another aspect of GW's use is a route for disposal of liquid effluents, both excess runoff through soak-ways and sewage, latrines and septic tanks. The asset value of this aspect is less clear cut, being of more value to the producers of effluent than the users of GW, who may suffer from pollution as a consequence. Hence, there is an urgent need to look into excreta disposal option, which will not contaminate the groundwater.

[1] **Source**: Demographic and Health Survey (1992 & 1996), Bureau of Statistics, Planning Commission, Ministry of Health, Tanzania.
Brackets ( ) means 1996 Survey figures

Furthermore, it is clear that, the existing sanitation situation does have its ironies in Dsm. The city has been experiencing increasing problems of water and sanitation facilities due to the accelerated influx of the people. The 'pull' towards the city is the outcome of poverty and lack of adequate paid jobs in the rural areas. This phenomenon has resulted into poor or no adequate infrastructure services in the urban area since provision did not cope up with demand. The national statistics shows that, 92% of the urban population and 84% of the rural population had latrines with questionable durability (Mzige, A. 2002). Those latrines are likely to be damaged or collapsed during the rain period and hence, spreading diseases like cholera.

Conventional forms of centralized and individual sanitation systems have proved not to offer sustainable solutions to the massive sanitation problems in the country. As an example, the city of Dar Es Salaam. has got an approximate population of about 4 million inhabitants at present, 5% of these only are connected to the sewerage system, the rest use pit-latrines, septic tanks and some have no excreta disposal places. Those without any facility use the 'bush sanitation' or a neighbour's latrine. Despite the intensive efforts made by the government in trying to privatize water and sewerage utilities to improve the service delivery, still many areas have not been able to get adequate supply of water and sanitation services. Initial costs are normally quite high for the users.

Moreover, intermittent supply and scarcity of water has forced the government to drill more than 472 boreholes from 1997-2001 with a maximum total capacity of 120 m^3/h (Mato, 2002) to meet the demand of the rapid expanding city. From 1975 to 1997, the pace of borehole drilling remained very low except for shallow wells in areas without piped water connections. Today, there are more than 850 boreholes supplying water for drinking and industrial purposes. More than 35 boreholes are connected to the main distribution system of the city (Mato, 2002). The present total water production is 273,000 m^3/day from sources of Lower Ruvu 182,000 m^3/day, Upper Ruvu 82,000 m^3/day and Mtoni 9,000 m^3/day, while the demand was 410,000 m^3/day in 1999 (Msimbira, 1999) and at present, it has risen to about 680,000 m^3/day. To meet this demand, almost Tshs. 600 million (USD 640,000, exchange rate of 2002) are needed to extend the existing system, let alone the costs of operation and maintenance. Similarly, the costs of operating and treating the wastewater have been exorbitant. In addition to that, "the water, precious liquid" has been used as a transport medium of faeces, urine and other wastes, an issue which burden the low-income population who buy a bucket of water (20 litres) at 0.05 - 0.10 USD. For normal functioning, a human body requires about 3 - 10 litres of water per day depending on climate and work-load, while, for flushing about 0.5 kg of faeces, one needs 9 to 20 litres per flush depending on the type of toilet. This means, a very small fraction of faeces contaminates a huge amount of treated water, which will require treatment again as wastewater. This practice is costly and calls for a change in the way we think about our excreta disposal options.

The current way of thinking, is to regard excreta as a resource rather than a 'waste' and hence, the concept ecological sanitation. The ecological sanitation represents a shift in thinking about and acting upon human excreta. It is a "closed loop" approach preventing pollution by recycling nutrients and organic matter, and is applicable in the North and the South, for rural and urban areas, and for rich and poor alike (Esrey, et. al, 2001).

About 25-50 kg of faeces is produced per person per year. This contains up to 0.55 kg of Nitrogen, 0.18 kg of Phosphorus and 0.37 kg of Potassium. Furthermore, an adult may produce ~400 litres of urine per year containing 4.0 kg of nitrogen, 0.4 kg of phosphorus and 0.9 kg. of potassium Johnsson (2002). The daily urine production depends almost entirely on the liquid intake and the climate, and the concentration of nutrients depends on the intake. The daily intake of protein determines the urea in the urine. Taking these figures into consideration, it means that, in Tanzania per annum, we produce 9.5×10^8 - 1.9×10^9 kg of faeces with 2.09×10^7 kg of N, 6.84×10^6 kg of phosphorus and 1.41×10^7 kg of potassium. The fertilizer consumption in Tanzania was 53,883 tons in 1972; 142,676 tons in 1991 (Isaac, 1994) and 200,000 tons of which 25% was N, P, K in 1994. These figures indicate an increase in fertilizer consumption. Since the fertilizer factory in the country has been closed, exploitation of other means of getting the nutrients is necessary. This means there is a great potential in "human waste". Furthermore, the fertilization rate (Table 2), indicate that, there is a possibility of getting enough produce through nutrients from our human manure. Table 3 indicates the crop nutrient removal per hectare and the possible yield of different crops.

Table 2: Fertilizer rate for some crops in Tanzania

Type of plant	[2]Fertilizer rate (kg)			Total N+P+K (kg)
	N	P_2O_5	K_2O	
Citrus, coconut (123 plants/ha)	12.3	12.3	61.5	82.1
Sorghum, cassava, sweet potatoes	12	60	-	72
230 kg. cereal fertilizer need	5.6	0.7	1.2	7.5

Though plentiful everywhere, there is not much written about this subject of human manure, indicating that, it is a subject most people tend to avoid. Major part of literature originates from Asian countries. Very little information is found on the use of human manure in Africa or South America. Attempts to address the question of human excreta has however, been pushed by the prevailing circumstances like high water table problems in some parts of Tanzania.

In recent years, nutrient budget and balance approaches have become widely applied in the African context. Studies have been undertaken at a variety of scales: from plot and catchments to regional analyses and, sometimes, even continent-wide assessments. The conclusions emerging from many such studies point to widespread processes of 'nutrient mining' and soil fertility decline. Considering the urgent need to increase agricultural production in Africa, these are alarming conclusions (Scoones and Toulmin, 1999) which calls for reuse of nutrients even from human manure to improve the situation.

Table 3: [3]Crop nutrient removal

Crop	Yield, kg/ha	N, kg/ha	P, kg/ha	K, kg/ha
Cereals				
Rice, paddy	4000	60	13	25
Wheat	3000	70	13	50
Maize	4000	200	35	133
Sorghum	4000	120	22	116
Tubers etc.				
Cassava	20000	125	13	125
Sweet potatoes	10000	90	9	12
Potatoes	25000	115	20	166
Others				
Soybean	1000	125	13	33
Ground nuts	1000	50	7	12
Sun flower	1000	39	3	62
Sesame	1500	45	20	8
Oil palm	15000	90	9	112
Sugar cane	90000	85	26	125
Sugar beet	40000	140	26	166

[2] Source: Semk, O. K. and Harrop, J. F. (1984), Fertilizer Recommendations on a District Basis in Tanzania, Technical Paper, with author115s modifications.

[3] Source: EUROCONSULT. 1989. Agricultural Compendium - for rural development in the tropics and subtropics. 3rd ed. Elsevier, cited in Johnsson, H. (2002), Ecological Sanitation Separation/Urine Diversion Handout, Uganda Kabale.

Other authors seconding the advantage of organic manure include Missar, 1997; Tomoji Egawa, (1974) and Strauss (1999) who said that nutrient deficiency need to be worked out before proposing the reuse of faecal sludge. Smaling (1993), gave an insight into the "non sustainable" agricultural systems in the majority of the countries in sub-Saharan Africa due to nutrient mining. He said, the long-term outlook for agriculture in sub-Saharan Africa is so bleak to an extent that, he questioned whether westerners should be prepared for just another form of colonialism. That is, a developed world, in future, structurally feeding a large part of the population in Africa, by virtue of its excess soil nutrients and surplus production. This is a frightening prospect, which, only a few decades ago, would definitely have ranked under 'science fiction'.

Furthermore, with an application of proper technology, biogas from human excreta can be obtained for lighting, cooking and other uses. One latrine user produces 0.02 - 0.03 m^3/day of biogas from 1 kg of waste per day (Eggeling, et. al (no date)). This means there is a potential of 80,000 - 120,000 m^3/day of biogas from Dsm. city population at the moment. With this amount of biogas one [4]could:

- Light, with an equivalence of a 60 - 100 watt bulb for 480,000 - 720,000 hours (133 - 200 days).
- Cook 240,000 - 360,000 meals for a family of 5-6 persons
- Drive a 3-tonne lorry for 224,000 - 136,000 km.
- Run a 1-hp motor for 160,000 - 240,000 hours (44 - 67 days)
- Generate 100,000 - 150,000 kW of electricity.

[4] The calculated figures were from the fact that, 1 m^3 of biogas can light 60-100 watt bulb for 6 hours or; cook 3 meals for a family of 5-6 persons; or drive a 3-tonne lorry for 2.8 km., or run a 1-hp motor for 2 hrs; or generate 1.25 kW of electricity according to van Buren, et. al (1979).

2.0 The Ecological Toilets in Tanzania

2.1 Rationale/Background information of the pilot site

The pilot ecological toilets in Tanzania have been built at unplanned settlement at the peri-urban part of Dsm. namely, Majumbasita area. It is about 11 km. from the city centre in the western direction and closer to the Dar-es-Salaam International Airport (DIA) in Kipawa ward. The current population is about 23,000 inhabitants. Houses are mostly occupied by owners, with an exception of few houses, which are inhabited by tenants. The size of plots varies from about 170 - 400 square metres (John, 2001) although one cannot dispute the ownership of bigger plots in future if people buy more land from owners who are interested to quit the area.

The piped water supply from the city network caters for only a small proportion of the inhabitants; many people (85%) depend on well water (John (2001). The quality of the well water is doubtful according to the study by Chaggu et. al (1993). The study concluded that, E-Coli count for samples from boreholes with depths 1.8 metres and 6.75 metres were 3000 FC/100 ml. and 178 FC/100 ml respectively. The intensity of E-Coli showed a decreasing trend with depth. The wells above 6.75 metres were free from faecal contamination implying that, water from deeper soil layers was bacteriologically safe for drinking purposes. Similarly, for the piped water supply, it was observed that, there is an increase in faecal pollution in the distribution main and service pipes (values ranged from 3 FC/100 ml. to 76 FC/100 ml. for 25 sampling points chosen in the distribution system). Furthermore, faecal coliform counts increased with time and decrease in pressure.

Majumbasita is one of those areas experiencing high water table problems in the city (~45% of the city, Mato, 1997). This situation is evidenced by the raised pit -latrines in the area, which accounts for 75% (John, 2001). However, some dwellers do not have any latrine facility; they use neighbours latrines or bush sanitation. Seepage from pit-latrines and septic tanks ends up polluting the ground water evidenced by the study results by Chaggu et. al (1993). These poor conditions have resulted into breakout of cholera mostly during the rainy season, possibly this is due to the pollution load in Dar Es Salaam. as predicted by Haskoning & M-Konsult, (1989) and shown in Table 4.

Table 4: Predicted pollution distribution Loads (kgs) in Dar es Salaam

Year		1999	2000	2001	2005	2009
Total population		3,362,744	3,631,763	3,885,986	5,093,735	6,929,970
[5]Domestic pollution	COD	191,676	207,010	221,501	290,343	395,008
	SS	302,647	326,859	349,739	458,436	623,697
	DS	538,039	581,082	621,758	815,000	1,108,795
	Total-N	26,566	28,691	30,699	40,241	54,746
	Total-P	5,044	5448	5829	7641	10,395

[5] values estimated using COD 57g.ca.day; SS 90g/ca.day; DS 160 g/ca.day; Total-N 7.9 g/ca.day, Total-P 1.5 g/ca.day adopted from Haskoning & M-Konsult (1989).

In addition to that, disposal of sullage, solid waste and children excreta, are not catered for adequately, as a result, they add to the health problems of the residents. In order to have a sustainable excreta disposal system that preserves the health of the people and do not pollute groundwater, to recycle the useful nutrients and organic matter available in faeces and urine, pilot ecological sanitation toilets were constructed at Majumbasita as a model for other places. The pilot project has been implemented by EEPCO (Environmental Engineering and Pollution Control, NGO) with a donor support from UNICEF and partial contribution by beneficiaries.

2.2 EcoSan structures at Majumbasita

2.2.1 Methods

Due to the fact that, the unplanned settlement of Majumbasita has been facing both water and sanitation problems, which partly include collapsing of latrines during rainy season, as a possible approach, the focus group, was formed from the community. This group had discussion with latrine users, ten cell leaders, masons and local government leaders. The project uses [6]PHAST tools in participatory approaches. A tool was used to map people's perceptions of how contamination travels to the mouth. It allowed the creation of pictorial flow diagrams by groups of men and women. The diagrams produced by focus groups in 16 communities showed considerable confusion about cause-effect relationships between steps in the process. People knew what was supposed to be good or bad for health without being quite clear why it was so. People were assisted to analyze their own situation and come up with solutions that are most appropriate for their local circumstances. The tool involved the EcoSan latrine users, school-teachers, customers and entrepreneurs. To ensure that, beneficiaries are adequately consulted, informed, educated/mobilized on urine separation EcoSan technology, during the project implementation, effective public awareness and mobilization through information, education and communication was carried out.

2.2.2 Technological Aspect

Two basic types of EcoSan structures have been constructed at Majumbasita. These are squatting and sitting type; both fitted with urine separation inlets. The urine is led through a pipe to a plastic container (tank) of 60 litres capacity outside the toilet filled with gravel and sand. These are emptied after every 13 days when they are full for a household of 5 to 6 people on average. The faeces are collected in a receptacle straight under the squatting hole. In order to maintain the principle of having very little water in the faeces, ashes are dropped into the pit-hole after every single use. The users co-operate in this aspect. Other suitable materials, which could be used, are soil or wood chips. As one chamber is being used, the "resource" in the other chamber has time to dehydrate and reduce pathogens through desiccation. The addition of ashes assists in the desiccation process and raises the pH, which aids pathogen reduction. Advantages of separating the urine from faeces is reduced odours in the latrines, minimum environmental pollution, potential to improve public health by reducing illnesses caused by faecal-oral transmission of pathogens and immediate use of nutrients which are readily available in urine. Furthermore, this practice facilitates the handling and the treatment of these two fractions separately and in an easy way.

So far, 96 EcoSan latrines (double vaults) have been constructed at Majumbasita, and two experimental (research-oriented) latrines have been constructed at Mlalakuwa area (double and triple vault), which is located about two kilometres from the University College of Lands and Architectural Studies (UCLAS) in the city. The overall dimensions (width, length, height) of the double-vault systems at Majumbasita were base 120cm., 200cm., 100 cm., and superstructure 120 cm., 200 cm., 200 cm. Solar panels were incorporated

[6] Participatory Hygiene and Sanitation Transformation (PHAST).) A set of tools for participatory analysis, planning, monitoring and evaluation designed specifically for water and sanitation programs.

into the double-vault dehydration design so as to increase the pathogen die-off (however, research work on its impact is needed). The research vaults at Mlalakuwa are using Simtanks (plastic tanks) of 3000 litres for urine and faeces mixed and 1000 litres separately for urine only and another 1000 litre for faeces only. These are mainly reactors for a PhD study, which is on-going at the moment.

The idea of performing studies is seconded by FAO Working Group, (1974), who said, except for materials which can be grown on the spot and incorporated in the soil or used as mulch, the bulk of organic manure have to be transported to the fields. Therefore, Governments and FAO should provide a new impetus to the improvement of rural transport. Furthermore, studies on the safe handling, storage and application of animal, human and other organics should be done. This is in order to avoid hazards from pathogenic organisms, toxic substances to man and animals and permanent damage to land for food production; to retain maximum nutrient content; and at lowest cost in land utilization. The acceptability to farmers of different practices must be assessed in the light of the economic and social pressures bearing on the decisions. Particular attention must be paid to labour requirements of alternative practices.

The cost of building materials for the double vault dehydration (excluding the study reactors) systems (EcoSan) was approximately USD 200 (2000/20001 prices). This cost includes part of the materials that are supposed to be contributed by the community. In the project area, Majumbasita, the community had a responsibility of construction of superstructure. As the demand increases, the project plans to decrease the donor contributions in order to make the project more sustainable. The demand of EcoSan latrines is high, about 17% of the households have requested to build the EcoSan toilet at Majumbasita. The high water table, soil conditions faced in the area and the advantages seen in the pilot structures accelerates the demand. (See photos below)

Top: **Photo 1:** Ecological toilet with urine tank in front and "uwani"

Left: **Photo 2 :** Urine tank and the back doors of ecological toilet together with the abandoned latrine pit showing high ground water table in the area.

2.2.3 Implementing agency

The EcoSan implementing agency at the moment is EEPCO with a research input from the University of Dar-es Salaam (UDSM) and University College of Lands and Architectural Studies (UCLAS) through the Environmental Engineering Department. Two students from both places are doing their undergraduate dissertations in Ecological sanitation. There is one PhD work, which takes a component of EcoSan as part of the study as well.

2.2.4 Selection of technology/project beneficiaries

Mara (1996), posed important guiding questions on the selection of technology; how does one choose between different technologies and which technology is most suitable for urban community? The most suitable sanitation option is the one that is cheapest, socio-culturally acceptable, technically and institutionally feasible, and environmentally friendly and results in a closed circle of nutrient's reuse. According to Winbald (ed. 1998), sanitation approaches must be resource minded, not waste minded. A system of sanitation that contributes toward equity and a sustainable society must meet or at least be on the way towards meeting the following criteria:

1) **Prevent disease**: A sanitation system must be capable of destroying or isolating faecal pathogens.
2) **Affordable**: A sanitation system must be accessible to the world's poorest people.
3) **Protect the environment**: A sanitation system must prevent pollution, return nutrients to the soil, and conserve valuable water resources.
4) **Acceptable**: A sanitation system must be aesthetically inoffensive and consistent with socio-cultural values.
5) **Simple**: A sanitation system must be robust enough to be easily maintained with the limitations of local technical capacity, institutional framework and economic resources.

EcoSan meets most of these criteria. Using them adequately in Tanzania needs to go hand-in-hand with education on how to use the structures.

2.2.5 Attitudes and behaviour Change for EcoSan toilets

Barriers to change exist in all countries, societies, communities and organizations. The nature of such barriers have been highlighted and clarified by the challenges posed by the implementation of urine separation EcoSan toilets in Majumbasita. Some of the barriers relate to their religions, taboos and cultural foundation. Many people feel that they are "breaking" their inherited rituals. However, this should often be seen as a question of awareness, influence and relates as much to institutions, households and individuals. Sanitation is to a large extent social phenomenon, rather than a technical one according to Schuringa (2000) and therefore, the project has taken into consideration the background information on cultural, social, economic and environmental factors influencing sanitation behaviour before the implementation of action plan.

African societies are faecalphobic due to historical reasons according to Missar (1997). He said, people lived together in relative small tribes, which spread over large areas, land was always enough and few people. The most common agricultural method practiced was the slash and burn method. When the soil started to get unfertile, people just moved on. In that situation, it does not pay to collect the human manure available. People relieve themselves in bushes or bury their excreta. In this way, most nutrients were returned to the ecosystem. Their taboo also plays a role in the habit of tucking human faeces as far away as possible. A good example is the deep pit-latrines found in almost all third world countries; people just dig a large hole and when it is filled up they cover it and dig another one. Another cause of not using human manure in agriculture are the government and NGOs health programs that were/are specialized in hygiene with regard to faeces. In this matter the right conditions to use human faeces was never there. Furthermore, lack of knowledge on the nutrients available in excreta and the way to get them accelerates the problem.

The sanitation behaviour is based on ideas and taboos associated with defecation and on traditional habits originated in local cultural, social and environmental conditions. Majumbasita is a settlement with mixture of tribes who are low and middle class people. They have variable cultural practices of using the toilet, for the low class people in the area, men use the toilet for defecation only. For urination they just ease themselves in a bathroom (commonly known in the area as 'uwani') or in the area surrounding the house. This practice has made it difficult in some houses to determine the amount of urine generated per day. The opted technology has been found to gain more acceptances to the people due to its conveniences and advantages to the environment. People have no resistance of handling feces especially when it is dry because they believe it is just the same as cow dung, however, they do not want to touch it if it is wet. In Kagera urine has been used as a neutralizer (medicine) if somebody has inhaled poison. They give that person fresh urine to drink. Furthermore, it is used as a pesticide to kill banana weevils. Two big religions at Majumbasita are Christian and Moslem; they both have a very influential impact on sanitation practices. This has caused a considerable adjustment on the design of EcoSan toilets for the area. An ablution part had to be included for those using water for cleansing. Sanitation practices are not only based on culture and environmental conditions, but also on access to sanitation technology in terms of knowledge, materials and funds.

PHAST methodology was used during the implementation stage as well so that the community in the area may support the improvements with sustained behaviour change needed for improved health. A thorough understanding (awareness) of ecological sanitation, proper use of latrines and hygienic consideration together with the project sustainability once the donor funding is phased out, was created by involving the UDSM, line ministries, that is, Ministry of Health, Agriculture, and Water. The experience gained when conducting the awareness creation showed that, when people see for themselves how a well-managed ecological sanitation system works, most of their reservations disappear. The encouraging results are available from the pilot projects carried out at Majumbasita. Urine is now gradually being applied as a fertilizer. A garden has been established at the school compound and most of the parents and community passing-by learn the importance of urine as a readily available fertilizer. Using cow dung or composite wastes is a normal practice in Majumbasita. Some of the people diverted the urine into the shallow pit near the tree or close to the garden.

Urine could as well be applied in places with multipurpose trees. These are all woody perennials that are purpose fully grown to provide more than one significant contribution to the production and/or service functions of a land-use system. They are classified according to the attributes of the plant species as well as to the plant's functional role in the agro-forestry technology under consideration (Burley, 1984). Some of the agro-forestry technologies which may use the separated urine include trees in cropland (mixed intercropping), hedgerow intercropping, trees in homegardens, live fences and hedges, trees on borderlines and boundaries, windbreaks and shelterbelts, trees in pastures and rangelands.

2.2.6 EcoSan toilets costs comparison

Due to its simplicity in construction EcoSan unit has been using a variety of materials especially for superstructure, a practice that cuts down a good part of the cost of toilet (see photo; 3,4,5,6 &7).

Photo 3: EcoSan Toilet with cement block

Photo 4: EcoSan toilet with Corrugated iron sheets

Photo 5: EcoSan toilet with thatch superstructure

Photo 6: Left: Squatting EcoSan pan with urine diversion

Photo 7: Right: seat pan with urine diversion

The costs shown in the table below are based on Majumbasita toilets and locally availability of materials. The urine diversion toilet, VIP, [7]SanPlat and traditional pit latrine are the main types of toilets found in the area. They all require to be raised slightly above the ground due to the

Table 5: Costs comparison based on Majumbasita

Type of Toilet	Substructure materials	Superstructure	Roofing	Urine tank 60 lts	Ventilation pipe 100 mm	[8]Estimated costs (USD)
Eco-san (Urine Diversion Toilet Double vaults)	Blocks 150mm	Blocks 150mm	[9]CIS	1	2	200
	Blocks 150mm	Palm leaves (Thatch)	CIS	1	2	120
	Blocks 150mm	CIS	CIS	1	2	140
[10]Traditional latrine	Lined Blocks 100 mm	Blocks 150mm	CIS	-	1	82
	Lined Blocks 100 mm	Palm leaves, logs (Thatch)	None	-	-	65
VIP	Blocks 150mm	Blocks 150mm	CIS	-	1	250-300
SanPlat	Blocks 150mm	Blocks 100mm	CIS	-	1	185
	Blocks 150mm	[11]Timber & thatch	CIS	-	-	97

presence of high water table, and this is a reason why EcoSan toilet fit to be integrated easily because no pit is required in this system. Of course, if one compares operation and maintenance costs, the urine diversion toilet wins by a wide margin, as there is never any pit to empty or superstructure to be moved or rebuilt. So if one compares lifecycle costs, a urine diversion toilet is actually more economical.

The rule of thumb for affordability according to water officials is that, consumers should never have to pay more than 3% of their gross family income for water supply. Likewise, they should never have to pay more than 3% for sanitation services.(Mutegeki, 2000). This means that, there is meagre financial input, which could be afforded by the users.

2.2.7 Gender and EcoSan toilets

In this paper, gender is used to denote the manner in which males and females are differentiated and ordered in Majumbasita socio-cultural system. That is, different areas of responsibility, work and authority held by men and women, and the impact these may have on their lives and positions within society. It is a dynamic concept, as work and position are not inflexible but change over time, within cultures and among classes.

[7] The SanPlat (Sanitation Platform) is a small locally prefabricated concrete slab designed for improvement of floor conditions around the drop – hole of the latrine. One of the great advantages with the system is that, the SanPlat can be integrated in the floor of a traditional latrine, hence, reducing even excluding the need of on – site cement works in peripheral areas. In the project area the SanPlat has been integrated with EcoSan technology for those with squatting requirements.

[8] Inclusive - community contribution , the costs varies due to types of superstructure materials used and economic status of Majumbasita

[9] CIS = Corrugated Iron Sheets

[10] When full, emptying costs per trip are 25-30 USD and high frequency of emptying during rain season

[11] Frequent change of material which adds to cost

Majumbasita is inheriting the national traditional trend whereby, the responsibility of fetching water for household use, storing water, cleaning latrines and performing most water using activities in the home lies with the younger and middle aged women and school children. Thus, the same group handles urine separation EcoSan systems. Nonetheless, one should not deny the possibility of men coming on board in case it is a profitable (cash-wise) enterprise like in paid latrines. From the handling perspective, the urine separation EcoSan system would have an impact on women and children who mostly handle it.

Experience from the field showed that, full benefits only accrue when women have more influential roles in management committees and maintenance of installed facilities, and men are encouraged to become more involved in activities such as hygiene education and sanitation. A key point here is that extending women's influence should not also increase their burden. It is the potential scope of women's involvement and influence that has been neglected in the past, this project had been concentrating on ways of stimulating and facilitating greater participation by women in decision making, planning, and management of the EcoSan structures.

Women Security, too, is increasingly an issue in violent urban environments and in rural areas away from human dwellings where privacy might be sought. Parents in the piloting area often withdraw their daughters from schools following the inadequate sanitation facilities for girls, for fear that their safety will be compromised. Understanding this fact, EEPCO has constructed separate units of EcoSan latrines for both girls and boys at Karakata primary school. This school lacks enough sanitation facilities to cater for 2920 pupils at the school. It had only 8 stances for both teachers and pupils. The standard of the Ministry of Education is one stance for 50 pupils, implying that, about 50 more stances are needed in order to suffice the school demand. EEPCO has reduced the number by constructing 6 stances and more stances will be built soon after the availability of funds in the coming phase.
Women in the project had a decision in choosing the EcoSan pan that suit their family needs. This was because, as agents of change, women are instrumental in moulding attitudes and practices among household members by being responsible for sanitary education of children, and their toilet functions. In this regard EcoSan squatting pan has been favoured when compared to the EcoSan seater. The reason behind their selection was the bigger number of family and easiness for young children to use the pan. The seat pan precluded the use by younger children of facilities. The squatting pan, which resembled very closely with SanPlat slab, has been gaining acceptance since its introduction. SanPlat gave the good reasons for urine separation, which included recycling of fertile value, durability of the Latrine and the control of smell. As selectors of sanitation practices women have been involved in all processes of the project decision, planning and implementation and they have been in the leading role of training and promoting sanitation at Majumbasita.

3.0 Conclusion

In conclusion, the following points are worthy noting:-

- Ecological Sanitation toilets are very suitable for the Tanzanian conditions especially urban areas experiencing high water table problems.
- Women are important change agents in promoting the EcoSan toilets at Majumbasita.
- Women and children are the prime handlers (keepers) of EcoSan toilets.
- Squatting pan type, is more preferred at household level than EcoSan seater type.
- There is an increased demand of EcoSan toilets at Majumbasita.
- Sewerage and septic tanks are expensive and not affordable by the people.
- The social acceptability and political will are very important for the success of EcoSan.
- There is high groundwater pollution from existing pit-latrines.
- There are cultural implications on EcoSan toilets at Majumbasita.
- Reservations of the people about EcoSan toilets fade away when they see a workable EcoSan structure.

4.0 Lessons learnt and future direction

From the results of the pilot structures at Majumbasita and the demand that is available at the moment, it is clear that, the future of EcoSan in Tanzania is bright. This is also true due to the poor economic situation in our country (for adopting sewerage system), high water table problems in some parts, increased need for organic fertilizer (industrial fertilizer is not adequately available and expensive) and the current international wave of a need for closed loop of nutrients.

Despite the importance of EcoSan toilets, promotion should always be done as new users come on board. This aspect has been regarded important in the experience gained in Uganda - Kisoro area where the EcoSan latrines have been used for longer time than in Tanzania. Furthermore, the future of EcoSan is in the hands of users. If users apply the required principles adequately, there will be less/no problems with the latrines and many people will like it. However, if they mess-up with the principles, nobody will like the technology and it will defeat the good purpose it had before.

Political support is very important for the promotion of EcoSan. If the politician works against it, it will not go far. It is therefore necessary that, adequate advocacy is given to the leaders so that they can see the suitable areas of intervention instead of interfering.

Compared to wastewater treatment technology, the development of sustainable options to treat faecal sludges (FS) has long been neglected (Strauss, Larmie,Heinss & Montangero, 1999) so EcoSan takes it on-board and should be encouraged.

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