Experiments with ecological sanitation and pit emptying in Maputaland, South Africa.

A description of visits made in 2000 and 2003.

Peter Morgan
Aquamor

Maputaland is the region of South Africa which forms the coastal plain of Northern KwaZulu Natal. It lies south of the Mozambican border and north of lake St Lucia between the sea and the Ubombo Mountains. The area is mostly flat and sandy with swamp and grassveld which drain into a number of extensive freshwater lakes and pans. The rural population of about120 000 people is widely scattered with corridors of denser settlement around the community centres. In 1996 the Ubombo Family Well Project was initiated in Southern Maputaland, as a result of a visit made by the Mvula Trust in 1995. *Partners in Development cc* was commissioned by the Trust to investigate a number of water supply and sanitation options in the area. The method of using hand drilled tube wells and bucket pumps has been and remains successful in this area. The promotion of family and school VIP latrines has also been undertaken by *Partners in Development*. Family VIP Latrines are normally constructed over pits lined with a series of five or six 1 metre (ID) diameter concrete rings each 40cm in height. A circular concrete latrine slab is laid over the upper ring and a pedestal made from concrete in combination with a standard toilet seat is constructed on the slab. The slab is fitted with a 110mm screened PVC vent pipe, and mounted with a suitable superstructure. The bulk of these materials are supplied by the project. The family supplies the superstructure and there is a variation in its design. Some are made of treated wood, others of concrete blocks. Others are made of poles with reed walls. All are fitted with a door. There is a demand for family sanitation. The method of lining pits with a series of concrete rings in this very sandy environment has been successful and was initiated in the Maputa Project of Charles Loew some years ago.

Start up trials in ecological sanitation and recycling

The first visit was made by the writer in November 2002 to initiate an interest in the concept of ecological sanitation in this project. Ecological sanitation promotes the concept of recycling of human wastes so they are seen as a resource rather than a nuisance. Throughout the world there is a trend towards using this concept which has been widely used in Asia for countless years. In Central America and Scandinavia and elsewhere the concept of using urine diverting pedestals is well developed. Here the faeces and urine are separated. This makes the faeces easier to handle since they are drier. In South Africa, Richard Holden of the Mvula Trust and Aussie Austin from CSIR are both undertaking research and development work in urine diverting technology. In Zimbabwe various other alternatives have been introduced as well as the urine diverting techniques into the concept of ecological sanitation. These include the use of shallow pits where both urine and faeces are added together with soil, wood ash and leaves. Where these extra ingredients are added the conversion of excreta into “humus” takes place more rapidly, partly because of the introduction of beneficial soil bacteria in the soil and fungi on the leaves. The aeration of the resulting mix also helps to promote the composting process.

Two technologies have evolved in Zimbabwe, the *Arborloo*, and the *Fossa alterna*. In the case of the *Arborloo*, a shallow pit, normally up to one metre deep is used like a pit latrine, but the addition of soil, leaves and ash are encouraged at regular intervals, preferably after each visit. The addition of plastic, rags, bottles etc which are not biodegradable is discouraged. When the pit is nearly full, the structure (which is designed to be portable) is removed and the portable slab (which should be fitted with handles) is moved to another similar pit nearby. Such pits are normally protected with a ring beam of bricks or concrete. The used pit is topped up with fertile topsoil, at least 150mm deep, and a young tree is planted, protected from animals and watered. Planting trees during the rainy season helps survival. There are many suitable trees and the best include guava, paw paw, banana and mulberry. However a wide range of trees can grow in these conditions. Tests are underway on a wide range of trees in Zimbabwe. The end result is a "sanitary orchard," or a series of scattered trees, where perhaps a tree may be planted every year on a full pit. This requires space and normally the method is most suitable for rural areas where there is space.

In both rural and higher density peri-urban settlements another technique is used. This is called the *Fossa alterna*. In this case two shallow pits (1.2m to 1.5m deep) are dug and partly (or fully)lined near to each other. In this case the single cover slab and superstructure are used on only one pit at a time. When the first pit is nearly full (with urine, faeces, soil, leaves and ash), the slab and structure are transferred to the second pit, which is normally empty at this time. The first pit is then topped up with good layer of leaves and soil (at least 150mm deep) and left to compost for a full year. The empty or composting pit can be covered with a wooden lid. The contents change their form during the year into a safe and nutrient rich humus which is valuable in the vegetable garden. Normally the structure on family facilities needs moving at about yearly intervals which gives ample time for the ingredients to be converted and easy to excavate from the shallow pits. The entire cycle can be undertaken within a small area (about 1.5 m X 2.5m) and thus is suitable for many peri-urban areas. The method is currently being tried in Zimbabwe, Mozambique, Malawi and Kenya. Several manuals on the topic of ecological sanitation have been written by the writer. The method is also available on a CD.

Aim of visits

The aim of the 2000 visit to Maputaland was to introduce the concept of eco-san (using the *Arborloo* model) into the project area and build a few demonstration latrines with portable structures and slabs and plant a small range of trees in pits already full (these being full standard VIP latrines).

However the ecological methods developed under the ecosan umbrella may have a significance impact on the huge potential existing problem of emptying full pit latrines. Hundreds of thousands of pit latrines in the sub region are full and have been abandoned. This means that new facilities must be built. Currently methods of linking ecological sanitation with older existing pit latrine programmes are being tested in Zimbabwe.

In the standard pit latrine, soil, leaves and ash are never routinely added to the pit and the contents digest inefficiently in an anaerobic environment. By adding fertile soil, leaves ans ash deep into the pit contents, air is added and also a complex mix of animalcules and micro organisms which should help promote the aerobic process of conversion of excreta into

humus. It will be recalled that when soil and ash are added regularly to the pit contents the conversion to humus is relatively rapid.

Thus a further aim of the visit was to top up full pits with soil and rod in the soil as deep as possible in an attempt to promote the conversion of excreta to humus in existing standard pits. It was felt that this would make them easier to excavate in the future and also less nauseating. The 2003 visit was made to check and report on the fate of the three trial latrine sites which had been moved or partly excavated and the pits filled with soil.

Field work

A number of sites were visited in the Mseleni area near the hospital. These were mainly family latrine sites.

Site 1. Latrine of Jobe

Visit of 2000

This was a conventional VIP latrine with pit lined with 5 concrete rings (each 1 metre ID, and 40cm deep. Thus the full depth of the original pit was 2m (total volume = 1.57sq.m.). The rings were capped with a circular concrete slab with concrete pedestal on top with plastic seat and cover. The superstructure was made of wood with legs at the 4 corners and fitted with a door. It was portable and located near Mseleni hospital.

Since the pit was almost full, it was decided to transfer the slab and structure to a smaller temporary pit and add soil to the existing pit and plant a tree. As a temporary measure a 200 litre steel drum (with top and bottom removed) was placed in an excavated hole next to the existing latrine which was now almost full and had been in use for 5 years (1995 –- 2000). The soil throughout the region is sandy and pit excavation can be undertaken quickly and easily. The sandy soil was dug down underneath the drum to a depth of 1.4m (drum depth = 900mm, drum diameter = 570mm).

The 200 litre drum dug into the sand next to VIP latrine

The structure was made of treated wood with four legs which held it in the soil. Four men were able to remove the structure and put it to one side. The slab/pedestal structure was then shifted over the drum and the structure placed once again over the slab/pedestal.

The 200 litre drum has been covered with the slab and pedestal and the superstructure is now being fitted (2000).

Dealing with the used pit.

The contents of the used pit came up to the level of one ring down. Humus like soil was found in the area under trees and this was taken and placed on top of the pit contents. Using poles, the soil was rammed into the pit contents as deeply as possible. (28th Nov. 2000). Most of the humus like soil was taken from under two trees, the Mkhulu and Mvongothi trees. Humus like soil is known to accumulate under trees as the leaves fall to the ground over a period of years. The pit contents were somewhat fluid.

Humus like soil being added to used pit (2000)

After 2 days the site was revisited. An attempt was made to use a hand auger to drill a hole in the pit contents. This was partially successful as the addition of soil had reduced the fluidity the contents at the top. Some material was withdrawn from the centre and replaced with humus like soil down about 1m. Soil could not be introduced deeper than this. The pit was topped up with soil and planted with a banana and paw paw tree and watered.

The toilet as it was left in 2000 with trees planted on the pit covered with soil

The concept on trial here is that the smaller secondary pit (with drum) may be put to use whilst the larger primary pit (with rings) is decomposing. However the rate of decomposition of standard pit contents (without soil/ash added) is not known.

Site 1. Visit of 2003

The same site was visited nearly 3 years later in October 2003. The drum became filled very rapidly after November 2000 and an attempt was made to excavate the original pit a few months later. Some material was excavated but the toilet was abandoned. On examination in 2003 the drum was full (family size was 16) and the pit contents had contracted to 2.5 rings down (about one meter or half way down). Excavation started at 8.00 am. And was completed at 9.00 a.m. Some raw material was excavated but most was converted. Most of the material had been converted to humus. The pit also contained a lot of foreign objects like rags and wood etc.

On the left the pit as it was found with a soil like surface. Most of the pit contents were humus like and relatively easy to dig out. There were many rags and bits of wood. Three men took turns to dig out the remaining 1meter of contents which took one hour.


The pit being emptied. The men wore plastic gloves made of old bags. A pile of excavated pit contents was built up around the pit. Note the wood and other rubbish.


The short spade made up by Stephen Nash during the excavation. This was a valuable tool for the job. On the right the completed excavation


On the left the completed excavation leaving a pit 2m deep and 1m in diameter. On the right the men gather dried leaves. These will be placed down the pit.

Two full bags of dried leaves were thrown down the pit. These leaves help to start the conversion process from excreta into humus. The family members are encouraged to put down soil regularly into the pit and also leaves. The are also encouraged not to put down rags and other garbage.

The two bags of leaves fill up the lower ring of the pit.

The concrete slab is moved from the drum pit to the larger pit. The drum is filled with soil


The slab and pedestal are placed on the newly emptied pit. This is followed by placing the superstructure over the pit.


Finally the site is cleared and prepared for use. The family are requested to add leaves and soil to the pit regularly. In this case 5 litres of soil per week. Leaves should also be added from time to time. The pit will be examined in the future to test the filling rate (16 persons). The whole job was completed in 2 hrs.

Site 2.

Visit of 2000

This was the second family latrine dealt with near Mseleni hospital. It was placed near a store and owned by family Nhlenyama. A 200 litre drum similar to the first was dug in to the sandy soil next to the existing latrine and dug down to about 1.2m depth. . The wooden structure like the first site was made of treated wood with four footings which anchored it into the ground. This was found to be an effective portable structure suitable for the *arborloo* principle. The structure was removed by digging down around the footings. The slab and pedestal unit was also removed but broke up since there was not reinforcing in the slab.

The exposed pit contents came up to just under the first ring down. This latrine had been abandoned earlier and the contents were less fluid than in the first case. The pit was topped up with a humus like soil taken from under nearby trees. This was not rammed into the pit contents. A paw paw tree was planted in the topsoil and then watered. The tree was protected from animals.

Stephen Nash plants a paw paw in soil filled used pit

A new slab was brought in and attached to the existing pedestal and mounted over the drum lined pit. The superstructure was then placed over this.

Site visit of 2003

Like the last site, the small drum had filled up fast and an attempt was made to empty the pit planted with a tree, which meant taking out the tree. However the pit could not be excavated very deeply. Like the last pit the pit was half filled with contents, the upper most being dry and soil like. However further down the pit contents became smelly and less like humus. However pit excavation continued as the contents were partly converted. Digging was completed in about 1.5 hours. Once fully excavated two bags of dry leaves were added to the empty pit. The concrete slab was moved over onto the empty pit, but part of it was broken. This will be replaced and the superstructure fitted.

The material excavated from this pit contained a wide variety of non compostable material, particularly plastic bags which were difficult to dig out and place in buckets. Two ten litre buckets were used to excavate the pit in rotation. The men were persistent and were able to empty the pit down to 5 rings. In fact a further ring (no.6) formed part of the pit lining, but it was decided to stop the excavation at 5 rings and add leaves.


The site on inspection in 2003. The 200 litre drum in the toilet was full. The 1m diameter concrete lined pit was half full.


Buckets were used in rotation to take out the pit contents. The short spade also helped. A great deal of rubbish, mostly plastic and rags was also excavated.


Plastic bags were used as gloves on this experimental excavation. Protective clothing for this job is important. Once emptied, two full bags of dried leaves were added to the 2m deep pit.

The ring lined pit with 2 bags of leaves at the base. Rolling the concrete slab over onto the newly excavated pit.

The site as it was left with slab and pedestal over newly excavated pit.

Site 3.

Visit of 2000

At Mabika in the Jobi Ward close to Hebron store, visited 30th November 2000. This was an interesting sanitary site for several reasons. Many earlier pit latrine sites had been used and abandoned. Two current pit latrines were in use - they were unventilated and very odourous. Two earlier pits lined with steel drums were seen, one dating back to 1990. This was still well shaped but well rusted and weakened by time. Another full pit covered with steel bars and sheets had been planted with sugar cane. This cane was growing well although the soil in which it was planted was slightly odourous. This serves as a rare example of local planting on a full pit latrine site and reveals that planting on old pits is known within the culture.

An earlier pit latrine with a pit lined with about 5 concrete rings (1m diameter) was built in 1990 and had filled up by 1995 (this was heavily used). This was probably built as part of the Maputa project. This had been abandoned about 5 years ago and had been covered with undergrowth.

It was decided to attempt to excavate this pit to observe the contents after 5 years of abandonment, with the lower pit contents dating back almost 10 years. The contents came up to a level just below the upper ring. The dig proved to be very revealing and also offensive later on, as the deeper layers were excavated. Spades and a badza were used in the excavation. The upper sections of the pit contents were like sand. Considerable amounts of rags, plastic, old cloths and some bottles & glass etc were found in the pit contents which made excavation quite difficult. The pit contents were inoffensive down to about 1m - 1.2m depth. Then plugs of offensive material were found, particularly in the centre and the dig stopped at an excavation depth of about 1.2m. This was about half way down the full pit.

Digging out the top of pit filled 8 years earlier

Below this level a hand auger was used to excavate cores of the material. This material was less offensive on the sides of the pit and sandy in texture down to 2m depth. The material had a slightly fishy smell, but not very offensive.

Further down the pit contents were foul and excavation became impossible.

An auger hole was made down the centre of the pit and this material was found to be very offensive and much like fresh excreta. However the excreta must have been deposited about 7 or 8 years before and must have existed in totally anaerobic conditions. There was no conversion to humus or any evidence of a change. Perhaps this goes to show how important aerobic conditions and the close proximity to soil and its living organisms are to a successful conversion of excreta into humus.

Samples of the "raw excreta" were transferred to a plastic bucket interspersed with humus soil and also covered over with humus soil (30th November 2000). This bucket was taken back to Mseleni Hospital, planted with a fern and watered. 3 months later this material had converted into a pleasant humus. This demonstrated the importance of adding soil and air to the excreta to assist the conversion to humus. The excavated holes in the pit contents were filled with a humus like soil in an attempt to promote accelerated conversion of excreta deeper in the pits.

The excavated soil taken from the upper part of the pit was transferred to another shallow pit and planted with a young avocado tree found on site. The pit was topped up with a layer of soil and covered awaiting future excavation. Those shallow pit sites which had been abandoned earlier in this year or last year still smelled bad even although sandy in texture. This suggests that sand alone does not perform the same role in promoting conversion of excreta into humus compared to the fertile living soil. Sand would be far less fertile with little humus content compared to a good topsoil which has much humus and living organisms contained within it.

This last site showed very clearly the problems encountered with emptying pits filled with rags, cloths, bottles, plastic and glass etc. These items do not disintegrate and make manual excavation difficult and machine pumping impossible.

Visit of 2003

This site was revisited. The pit had been covered with a tin sheet and left untouched.

The tin sheet was removed and revealed a pit where the contents were 3 rings down. The pit material was very sandy and easy to excavate and completely converted into humus. The material was dug down to 5 rings and two full bags of dried leaves were added to the base. The top ring was fragile and became broken.

The intention is to repair or replace the uppermost ring and make a new slab and pedestal for this site and put the pit back into use by relocating one of the portable wooden structures on the plot.

This will then make 3 sites where pits have been excavated down to 2m (on a 1m diameter pit) with two bags of dried leaves added to the base of the pit. In all cases the family members have been requested not to throw garbage, plastic or rags down the new pit and to add soil and leaves regularly.


The pit as it was discovered in 2003. The tin sheet has been removed and the top ring collapsed. There are plans to refit another top ring, caste a new slab and put the pit back into use.

Simple guidelines on use of ecological pit latrines

Clearly on all new eco-latrines designed for later excavation two basic guidelines should be adhered to:

1. Regular addition of soil, leaves and wood ash to the pit helps to convert the excreta, and makes excavation much easier and far less offensive. Fully converted excreta will not be offensive at all. The regular addition of these extra ingredients increased the rate of filling but makes the subsequent manual excavation of the pit much easier and more acceptable. If ash is not available the addition of good topsoil will do. The final material has a far better texture if leaves are also added.

2. No rags, cloths, bottles, plastic, glass or other non biodegradable items should be thrown down the pit. These make pit excavation difficult, even if the excreta has been converted.

Ongoing work.

It is hoped that the various sites described above will be examined from time to time to take note of the filling rate of the pits. Families should be encouraged to add the extra ingredients regularly. The ideal scenario would be to construct a few extra sites where two sets of rings were dug in to the ground near to one another to make a *Fossa alterna* system. This could also be made with concrete blocks, but the ring method appears to be more appropriate for the loose sands of Maputaland. It would be useful to gather information on family size and filling rate of the pits where families are adding the extra ingredients. It appears that pits of 1m diameter and 2m deep are filling in about 5 years. The families in question may be quite large however. In well drained pits much of the fluid and wet sludge will be absorbed into the soil, ash and dry leaves added.

Summary

The work described here, may in future years have a great deal of value in South Africa (and elsewhere) where huge numbers of pits toilets have filled up and are currently very difficult to excavate. They are therefore abandoned in most cases, and the reusable materials of both organic and inorganic origin are never recycled and put to further use.

The ecological methods described here when adapted to the use of pit latrines, will certainly make manual excavation much easier and acceptable. Mechanical emptying using tankers is clearly difficult if not impossible where so many other items are added to pits other than excreta. Manual digging may be the only means. Such digging may be made much easier if the entire contents of the pit are converted to humus. Thus in a new generation of pit latrines this can be helped by adding soil, leaves and ash as a routine to the filling pits.

The work described above demonstrates that pit excavations can be made simpler, even in old pits containing raw excreta only, by adding extra soil to the pit after it has filled, and preferably leaves and ash as well. Ramming these materials deeper into the pit may also help. All pits used in this experiment were filled at one time with raw excreta only. The fact that all three pits have now been fully excavated provides evidence that this is possible. These studies show that even pits filled with raw excreta can be excavated provided that additional materials are added, and a period of time, preferably 12 months or more, is left for composting.

It is also possible to design slabs and structures which are portable, although in Mozambique the twin *Fossa alterna* pits are enclosed within a single superstructure. Even brick structures can be designed so they can be taken apart and rebuilt on a new site with ease.

There is much scope for the recycling of all components of the new generation of pit toilet. Superstructures can be designed with recycling or reuse in mind and all concrete work should have a long life, and be usable on a number of generations of latrine. Ideally roofs and vent pipes should be made of long life materials like asbestos.

It is hoped that Partners in Development will continue to experiment with this method in South Africa and increase our knowledge of this curious but important subject.

Acknowledgements

The writer is most grateful to David Still and Stephen Nash for their wholehearted support and encouragement. Special thanks are given to Lindi Still and Jenny Nash for their warm and generous hospitality. Thanks are also due to the men who excavated the pits.