

ECOLOGICAL SANITATION

A CONCEPT



Introduction

Ecological sanitation (ecosan) works on the principle that human excrement is not a waste product but contains the nutrients required to fertilise land and that it should be used for this purpose. The ecological sanitation cycle begins with containment, where excreta is held in the sanitation installation. The waste is then sanitised through one or several processes which cause pathogens to die off, the resultant safe soil conditioner (from faeces) and fertiliser (from urine) is then recycled and used to assist crop production. Figure 1 shows these processes alongside the harvesting, production and consumption of food that keeps the nutrients within the ecological cycle.

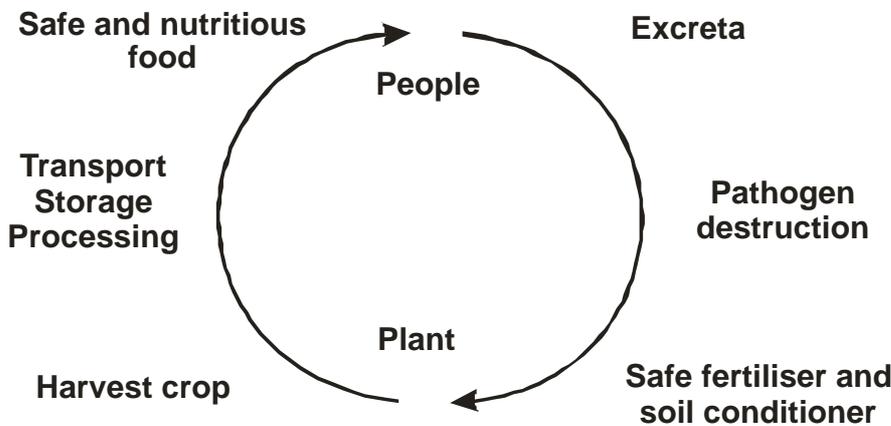


Figure 1: The principle of ecological sanitation is to return the valuable nutrients from urine and faeces back to the environment and avoid the pollution often caused by conventional sewerage whilst contributing to the food production. [Adapted from: Esrey and Andersson, 2001]

technical brief

Availability versus demand of key growth nutrients

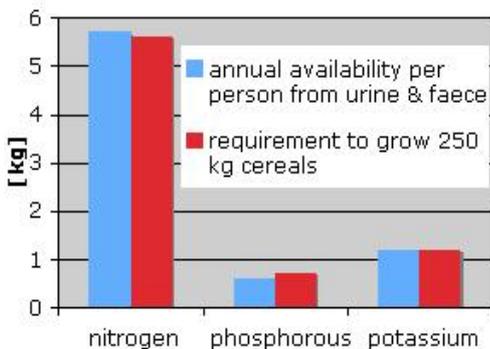


Figure 2: Nutrient availability for plant growth [Source: Smet and Sugden, 2006]

A wide variety of ecosan toilets exist, the complexity of which vary significantly as a result of options being explored in both developed and developing countries. This technical brief will briefly describe the main categories of ecosan toilet, the reasons to adopt ecosan options and some of the concerns practitioners have about their use.

Research indicates that human waste from one person can supply nearly enough nutrients to produce 250 kg of cereals annually (figure 2). The majority of the nutrients are contained within the urine component, and the faeces contain the most pathogens (although when treated correctly it becomes a good soil conditioner).

Ecosan is also growing to encompass both greywater (water used for washing clothes, cooking etc.) and rainwater, in addition to solid waste (garbage collected in a household). This technical brief will look simply at human waste, but references at the end of this brief provide links to other publications.

Why Adopt an Ecological Sanitation Approach?

Sewerage systems have been developed in the many countries and could take on the form of conventional, simplified or settled sewerage. The alternative to these systems are on-site sanitation facilities. Supporters foresee that ecosan systems can reduce the environmental pollution that other systems cause, in addition to recycling the valuable nutrients in the waste and improving food security. The benefits of ecosan over the other types of system, alongside some more general benefits are described below.

Sewerage Systems

Sewerage systems can cause environmental pollution as a result of inadequate treatment processes. Approximately 90% of sewerage systems in developing countries do not treat waste prior to discharge causing environmental pollution and increasing health risks to communities living near receiving water bodies. Ecosan provides treatment on-site and the by-product is most often re-used locally, eliminating large scale pollution.

Furthermore, sewerage systems require the use of large quantities of water to work effectively and in many poor communities there is no reliable water supply. One estimate is that 20-40% of water consumed in an average city goes towards flushing toilets. Ecosan systems only require water where it is used for anal cleansing, therefore eliminating this burden on water supplies.

On-Site Sanitation Systems

On-site facilities can also cause environmental pollution, initially as a result of seepage into groundwater. Ecosan systems mitigates this risk as a result of containing excreta in sealed vaults and/or storing them at only a shallow depth.

In urban areas the necessity to remove excreta from such installations can cause significant risks to the local community and workers. Correctly operated ecosan systems can mitigate these risks entirely by reducing pathogen content of faeces prior to removal. Further advantages of ecosan over on-site systems are that they generally smell less (attracting fewer flies), and in areas with hard ground or a high water table pit latrine construction can be problematic, ecosan overcomes this with options that do not require ground excavation.

Further Benefits

Ecosan systems have not always been driven by a need to recycle nutrients, water scarcity, high water tables, rocky ground and a need to minimise pollution are alternative reasons for adoption (Esrey and Andersson, 2001). Urban dweller's lack of land may mean they have no use for compost, in this case the material could be bagged and sold to generate further income (ibid), although this can be a problematic task to carry out if not done collectively. The use of ecosan has the potential to provide communities with food security for many years to come, as the compost not only provides nutrients, but also conditions the soil to which it is added.

In many areas subsistence farmers find it increasingly difficult to meet the costs of fertilisers, ecosan provides them with a cheap alternative to supplement their needs. Ecosan can also generate income through construction, operation and maintenance of facilities, providing bulk treatment in urban areas and re-sale of by-products.

As a result of being a low odour technology, ecosan also enables facilities to be constructed both inside and outside the home. Facilities constructed indoors can provide a safe and private environment for both women and children.

Critically, ecosan (if operated correctly) achieves the primary goal of minimising disease via treating faeces (or combined faeces and urine) and separating waste from householders whilst it contains dangerous pathogens. Crucially it also prevents these pathogens from entering the water cycle.

Types of Ecological Sanitation

The types of ecosan toilet can be separated into two categories, dehydrating and composting. Within these categories there is also a distinction between urine diversion (those that separate urine from faeces to achieve a variety of benefits) and systems which mix both urine and faeces. There are a variety of models operating in slightly different ways.

Types of treatment are split into primary and secondary treatment. Primary treatment occurs in the ecosan facility itself (on-site) through such processes as increasing pH level or reducing the moisture content. Secondary treatment takes place by transporting the waste to an alternative location (off-site) for further treatment such as composting or incineration. Many household facilities perform secondary treatment by leaving the waste in storage and not adding further faeces i.e. an alternating pit system. If human waste is collected and mixed together to be used on a large scale further secondary treatment should take place to ensure it is pathogen free (some users may not take as much care managing their own facilities, to ensure safe pathogen levels secondary treatment is highly advisable). For further details refer to the technical brief 'Re-use of excreta and urine from ecological sanitation'.

Specific details about a form of composting toilet are given in the Practical Action technical brief 'Compost toilets and eco sanitation toilets'. It is important to acknowledge that these toilets are part of ecological sanitation and to understand the overall concept. This section will briefly describe the characteristics of each toilet category and give some brief examples.

Dehydration Toilets

Dehydration toilets reduce the pathogen content in human excreta through a series of processes. The moisture content is reduced (therefore these types of facility always use urine diversion) and ash and lime are added after each use to increase the pH (above 9.5). The dryness and high pH, combined with the time left in storage, eventually causes the die off of all pathogens. The dryness of these facilities also means there is less of an environment for flies to breed, creating a more pleasant environment for the user.



In areas where water is used for anal cleansing there is a risk of the contents of dehydrating toilets becoming too wet and therefore not operating properly. The Kerala double vault toilet (figure 3) contains a trough over which to wash to prevent the contamination of the drying waste. In this system the water is collected together with the urine.

Figure 3: Kerala double vault dehydration toilet [Illustrator: Hans Mårtensson; Source: Winblad and Simpson-Hébert, 2004]

Composting Toilets

Composting toilets can treat human waste as either separated or mixed faeces and urine. The waste is mixed with organic waste from the garden and/or household to encourage the die off of pathogens. They can also operate by simply adding a handful of soil and ash after each use. The processes involved in killing off pathogens include moisture reduction (in some cases), temperature increase, storage and predation from competing bacteria (from household waste or soil). In developing countries soil composting toilets such as the Aborloo and Fossa Alterna can provide simple starting points for ecosan facilities.

The Aborloo (figure 4) is one of the simplest types of ecosan facility working on a composting principle. It consists of a shallow pit and a small amount of soil and ash is added after each use. When the pit is two thirds full the contents are covered with soil and a young tree planted upon the site. The latrine superstructure is then relocated to a new pit where the process is repeated. It is the safest way of recycling the nutrients available within human waste because humans do not have to handle the waste.

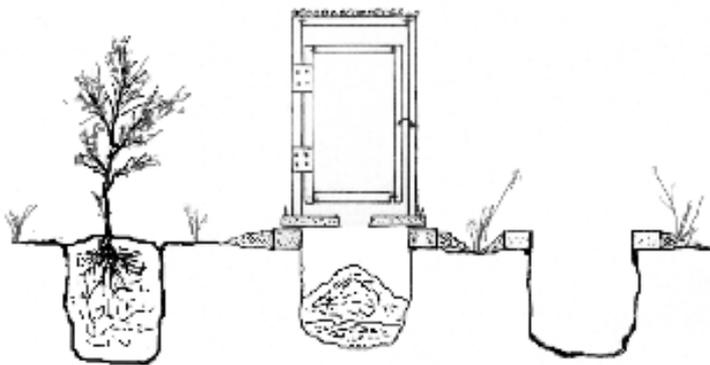


Figure 4: Aborloo toilet [Illustrator: Hans Mårtensson; Source: Winblad and Simpson-Hébert, 2004]

The Fossa Alterna (figure 5) is another form of soil composting toilet. It utilises a similar principle to the Aborloo, however it is more suited to areas with limited space as it only has two sites. The superstructure of the latrine is relocated from one pit when the other pit is full. After a certain period of time, the contents of the original pit can be removed and used as compost, the latrine is then relocated once more and the old pit re-used.

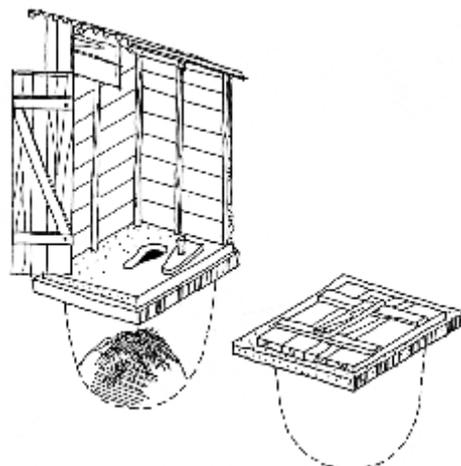


Figure 5: Fossa Alterna toilet [Illustrator: Peter Morgan; Source: Winblad and Simpson-Hébert, 2004]

Urine Diversion

Many ecological sanitation systems separate the urine component of the waste from the faeces. Urine contains more nutrients and less pathogens but if it is mixed with faeces it will require treatment before use as a fertiliser. Although urine diversion does not always occur it can bring a number of benefits, including (Winblad and Simpson-Hebert, 2004):

- simplifying treatment, due to urine and faeces requiring different processes;
- keeping urine relatively free of pathogens, allowing use of its nutrients without increasing risks;
- reducing odours, making facilities more pleasant for users; and
- keeping the volume of dangerous material low.

In a rural situation the best means of re-using urine is through direct application to land. In urban areas or households who do not own much land, it could be collected and stored (storing for over one month can make the urine even safer to use) or simply evaporated.

Potential Problems with Ecosan

The main risks associated with ecosan result from either mismanagement of the facilities (by, for example, not allowing enough storage time or allowing water into a dehydrating system), or poor construction of facilities. The outcome of both of these is that the pathogen content of the waste is not reduced to safe levels, putting a selection of stakeholders at risk, namely:

- those responsible for emptying the facilities;
- workers who spread the excreta across the land;
- farm workers who plant crops or walk on land to which by-product is applied; and
- consumers of crops that do not require cooking which have been fertilised with the excreta.

The greatest concern for pathogen survival is ascaris (a type of parasitic roundworm) which requires the longest storage (approximately 12 months) to reduce to safe levels. Other pathogens, including cholera, typhoid and hepatitis A, will reduce with more ease than ascaris. Refer to the technical brief 'Re-use of excreta and urine from ecosan' for more information on the diseases involved and the processes used to kill them.

Potentially, the largest barrier to successful ecosan is the lack of householder willingness to take part. In some societies the idea of handling human waste is too much of a barrier to overcome; these societies are often called 'faecophobic'. Alternatively, other societies (such as those in central America and China) are not averse to such systems and have been using human waste in agriculture for a number of years; these societies are called 'faecophilic'.

It is of primary importance when executing an ecosan program that people are correctly educated on how to operate and maintain systems. Ideally support should be provided during the first couple of cycles of operation and re-use. If users are not adequately trained and supported then the chances of them contracting disease during the operation of the facilities is high. On-site sanitation systems were created to form a barrier between deadly pathogens in faeces and householders; if ecosan is used incorrectly it holds the potential to counteract this purpose, putting householders and communities at risk.

Conclusion

The ecological sanitation concept can provide many benefits to communities and individual households. The recycling of nutrients not only improves the environment, but can provide safe sanitation in areas with water shortage and improve food security by providing cheap fertilisers.

However, the systems put a lot of emphasis on the householder to operate the facility and, more critically, they must operate it effectively else they will place themselves and the local community at risk. In urban areas there is likely to be a need for good service provision to empty facilities and take the compost to a suitable place to be used.

In order to realise the benefits of ecological sanitation care must be taken to develop a suitable solution for the area in question. Careful planning must take place to assess people's willingness to handle the by-product of ecosan, and whether they will be willing to use this for agriculture. There are a range of ecosan toilet options, some of which are more suited for communities who have not used ecosan previously. Further details of these systems can be found in the technical brief 'Composting and other ecosan toilets'.

References and Further Reading

- *Compost Toilets* Practical Action Technical Brief
- *Re-use of Excreta and Urine form Eco-san* Practical Action Technical Brief
- *Ecosanitation Special* Waterlines Vol 26 No 2 October 2007
- *The main features of ecological sanitation.* EcoSanRes Fact Sheet 2. EcoSanRes, Sweden.
http://www.ecosanres.org/pdf_files/Fact_sheets/ESR2lowres.pdf
- *Ecological Sanitation: Closing the loop.* Esrey, Steven A. and Andersson, Ingvar (2001)
UA Magazine 3, pg 35 – 37.
[http://www.ruaf.org/system/files?file=Ecological Sanitation - Closing the Loop.pdf](http://www.ruaf.org/system/files?file=Ecological+Sanitation+-+Closing+the+Loop.pdf)
- *Ecological sanitation and reuse of wastewater: A think piece on ecological sanitation.* Jensen, Petter, D. et al (2004). The Agricultural University of Norway, Norway.
<http://www.uio.no/studier/emner/medisin/inthealth/INTHE4000/h07/undervisningsmateriale/Water%20and%20Health%20article.pdf>
- *An ecological approach to sanitation in Africa: A compilation of experiences.* Morgan, P. (2004) Aquamore, Zimbabwe.
http://www.ecosanres.org/PM_Report.htm
- *Guidelines for the safe use of urine and faeces in ecological sanitation systems.* Schönning, Caroline and Stenström, Thor Axel (2004). EcoSanRed Programme, Stockholm Environment Institute, Sweden.
http://www.ecosanres.org/pdf_files/ESR_Publications_2004/ESR1web.pdf
- *Should ecological sanitation carry a health warning? Assessing the health risks of ecological latrines.* Scott, Rebecca (2006) WELL Briefing note 27. WELL, Loughborough University.
<http://www.lboro.ac.uk/well/resources/Publications/Briefing%20Notes/BN27%20Ecological%20sanitation.htm>
- *Ecological Sanitation.* WELL Factsheet. Smet, Jo and Sugden, Steven (2006) WELL, Loughborough University, UK.
<http://www.lboro.ac.uk/well/resources/fact-sheets/fact-sheets-htm/Ecological%20sanitation.htm>
- *Ecological sanitation – revised and enlarged edition.* Winblad, U. and Simpson-Hébert, M. (editors) (2004) SEI, Stockholm, Sweden.
[http://www.ecosanres.org/pdf_files/Ecological Sanitation 2004.pdf](http://www.ecosanres.org/pdf_files/Ecological_Sanitation_2004.pdf)

Useful Websites

- WASTE (a Dutch NGO) is doing a large amount of work on ecological sanitation. Information can be found at www.ecosan.nl
- A Swedish funded ecological sanitation research group provide a wide range of useful information at www.ecosanres.org
- The German international cooperation enterprise for sustainable development, GTZ, provide a wealth of technical information at www.gtz.de/ecosan

This Technical Brief was written by Niall Boot for Practical Action in November 2007.

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