WHAT IS DRY TOILET?

新しいSanitation SystemとしてのDry toiletの現状

The 2nd International Dry Toilet Conference の報告を交えて

東京大学 工学系研究科　環境システム研究室

参考機関

Dry Toilet Club in Finland

http://www.drytoilet.org/index.html

Gesellschaft fur Technische Züsammenarbeit in Germany

http://www2.gtz.de/ecosan/english/

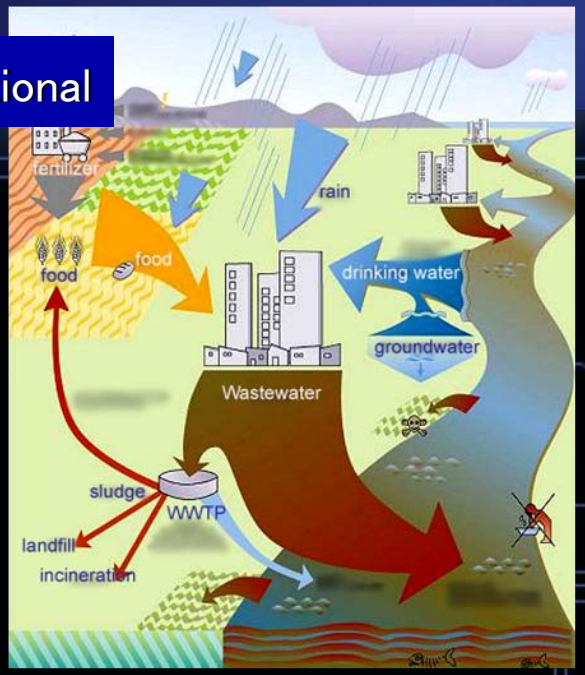
Composting Toilet World

http://www.compostingtoilet.org/

Eco Sanitation とは？

- 従来型下水道施設と異なり、水使用を抑え、循環利用を目指すシステム
- 特に水資源の乏しい地域や衛生施設の整備が不十分な地域、人口密度の低い地域などで有効な衛生システムと考えられる

Conventional



Eco-sanitation

Eco sanitation systemの対象カテゴリー

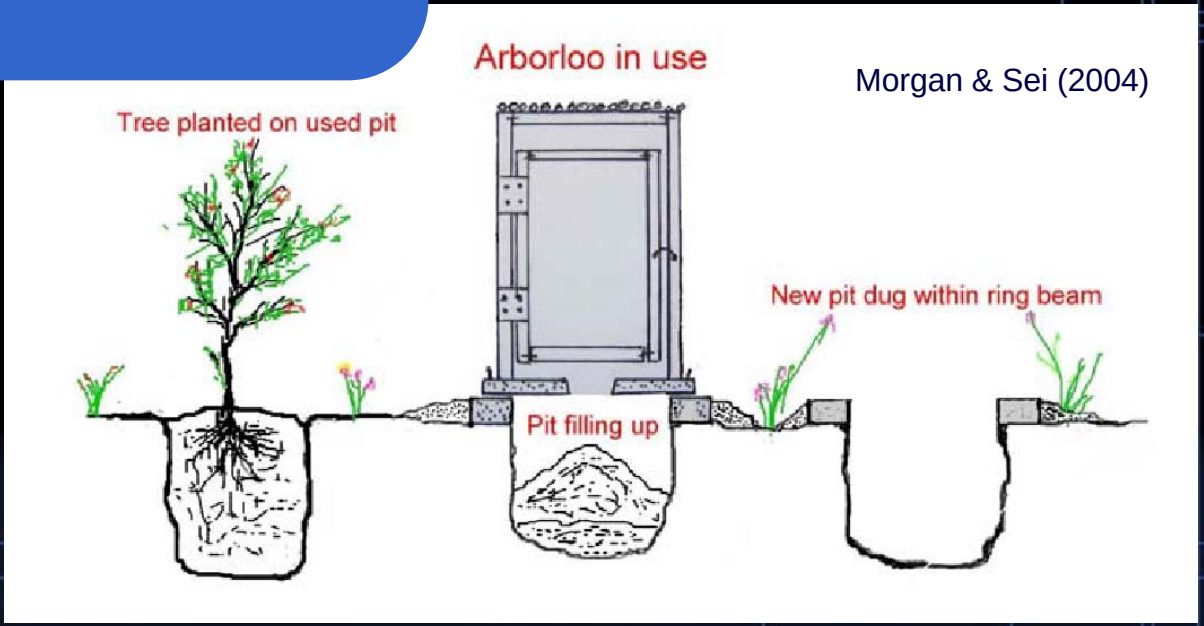
GTZ Technical data sheet より

様々なシステムの紹介

今回説明の対象にするシステム

- Urine Separation
- Dehydration
- Vacuum
- Composting

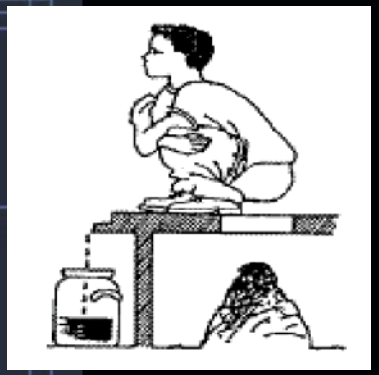
以下のようなpit systemのmodification等は省く



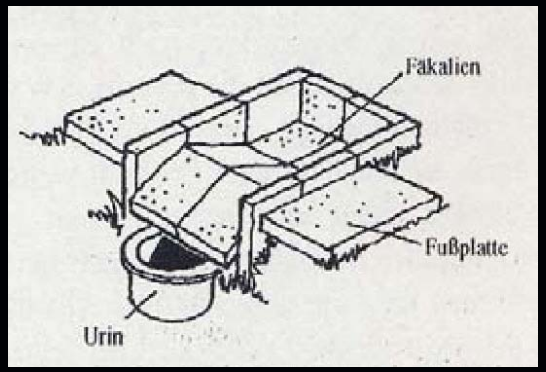
The Arborloo moves on a never ending journey leaving behind a series of fertile pits filled with a mix of human excreta, soil, wood ash and leaves etc which provide a suitable planting medium for trees when composted. Nutrients in the excreta are used by the tree to enhance its growth.

尿分離とは？

- 屎尿を別々に収集処理利用するシステム
- 尿中の窒素分を肥料として有効利用
- 屎から水分を分離することによる乾燥の効率性上昇

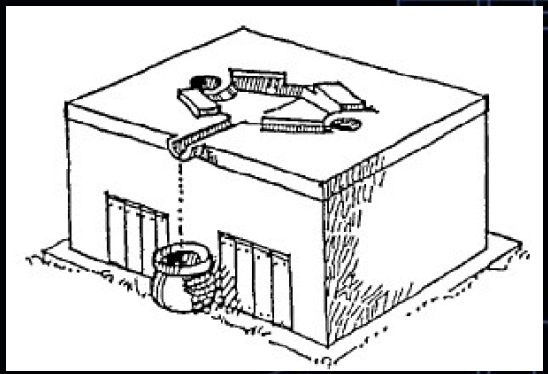


Dry Pit



Early model of urine diverting squatting toilet used in China

Urine diversion toilet with dual flush function



Vietnamese double vault dehydrating toilet with urine diversion

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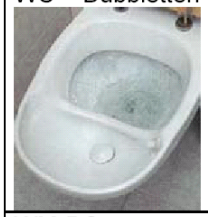
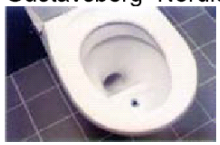
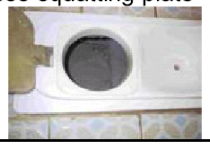
尿分離用に市販されているトイレ

	Toilet Model	Features
Urine Diversion Flush Toilet	WC – Dubbletten 	▪ Separate bowls ▪ Independent 0,1l urine flush, 4-6 l solids flush ▪ Child seat ▪ Wall or floor mounted ▪ Sanitary porcelain ▪ 700 EUR (mounting hardware and seat cost extra)
	WM-DS 	▪ Single bowl divided with wall into two ▪ Variable (0-0.7 l) urine flush volume, 3 l solids flush (also adjustable) ▪ Floor mounted ▪ Sanitary porcelain ▪ 600 EUR (includes seat and rubber device for connection to urine diversion)
	Gustavsberg Nordic 393U 	▪ Separate bowls ▪ Single 2 l small flush, 4 l large flush, 10% flush for urine bowl ▪ Wall mounted ▪ Sanitary porcelain ▪ 720 EUR (includes seat and metal attach-ments)
	Roevac No Mix 	▪ Two separate outlets ▪ Urine collected undiluted by means of a mechanical plug open when user is seated ▪ 1 l urine flush, 6 l solids flush ▪ Wall mounted ▪ Sanitary porcelain ▪ 1.080 EUR (includes mounting hardware and seat)

Urine Diversion Waterless Toilet	Separett Villa 9000 	▪ Waterless toilet ▪ Wall or floor mounted ▪ Front urinal funnel with 2 m ∅32 mm hose attached ▪ Impact-resistant high-gloss polypropylene ▪ Fan power consumption of 0.396 kWh/24h 700 EUR
	WM Ekologen 	▪ Front urine bowl with rear faeces drop pipe ▪ Minimal urine flush ▪ Sanitary porcelain ▪ 300 EUR
	Chinese squatting plate 	▪ Sanitary porcelain or ABS plastic ▪ Sliding lid offers hands free operation ▪ 8 EUR
	Mexican double vault	▪ Polished concrete ▪ 13 EUR
	South African 	▪ Plastic
	Toilet moulds for concrete pedestals	▪ Fibreglass ▪ 200 EUR

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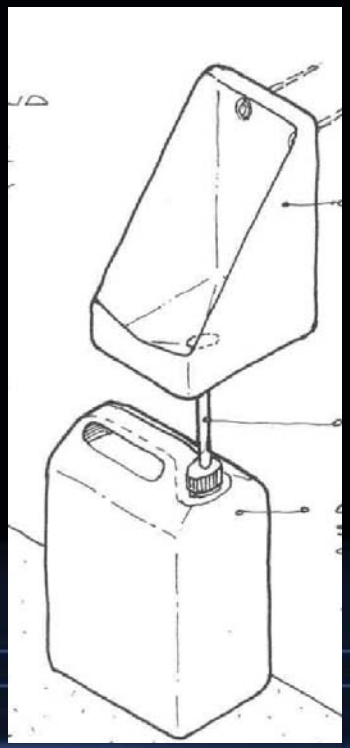
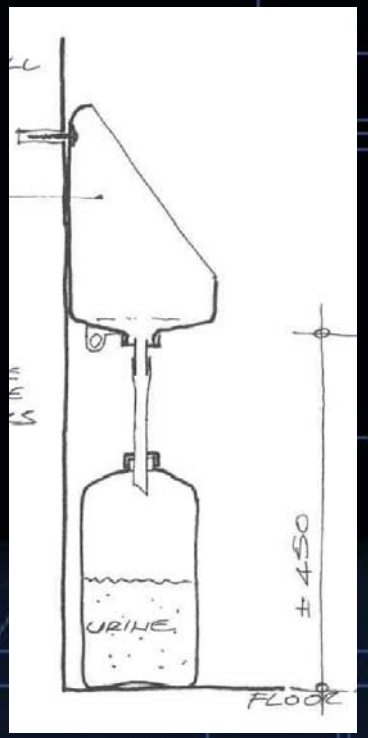
尿分離（希釈）

- with dillution
- low dillution
- without dillution

Urine diversion toilet with dual flush function

Waterless toilet





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尿分離ー収集・貯蔵方法

Pipes and tanks may require occasional cleaning to avoid clogging of pipes and to remove accumulated sediments in tanks.

Precipitation may occur to certain amount in urine pipes. However, available experiences suggest that the risk of clogging in pipes where urine is collected waterfree is smaller than in pipes from water-flushed urinals.

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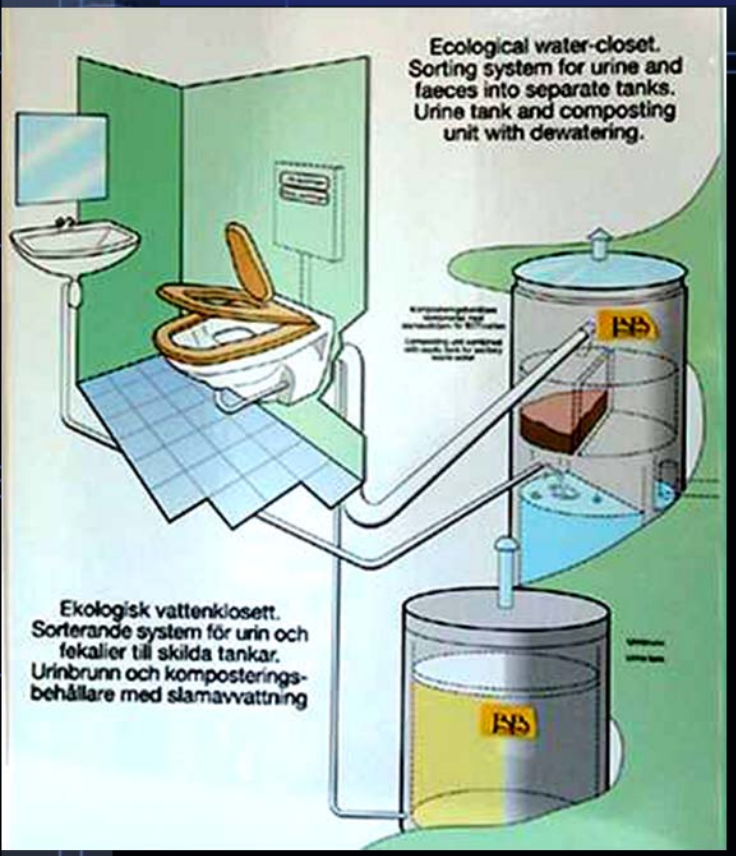
尿の農業利用



Urine application before sowing on a large scale (SLU, Sweden)

Guidelines for safe use of urine and faeces recommended that urine collected from many households for reuse in agricul-ture should be stored under temperature of 4-20˚C for 1-6 months depending on the types of crops. With average temperatures >20˚C, 1 month of storage is generally suffcient.

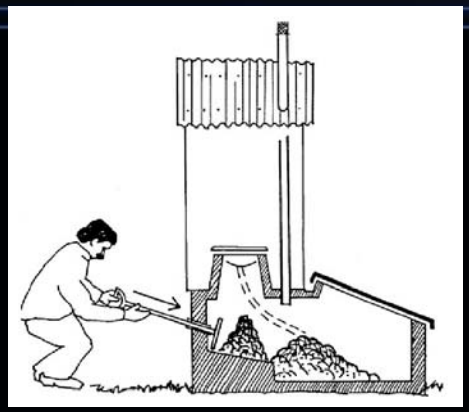
A general rule of thumb is to apply the urine produced by one person during one day (24 hours) to one square metre of land per growing season (crop). The urine from one person will thus be enough to fertilize 300-400 m^2 of crop per year and even up to 600 m^2, if dosed to replace the phosphorus removed by the crop.

塩類蓄積の問題は？

施肥時期集中の影響は？

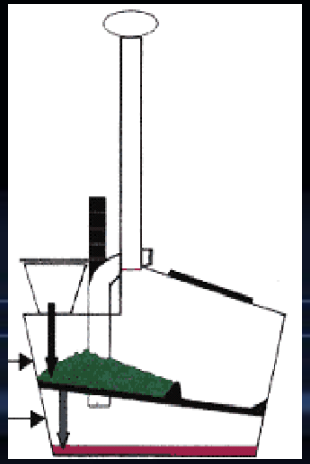
Dehydration

Double-vault dehydration toilet in Ecuador with inclined lids to increase the solar heating effect



Single-vault dehydration toilet in El Salvador: the pile of fresh faeces is regularly shifted to the rear of the chamber for drying

屎を太陽光や自然の換気により乾燥させるシステム。十分な換気システムを確保することが重要。



Without urine diversion; Solid and liquid is separated at the initial stage of entering

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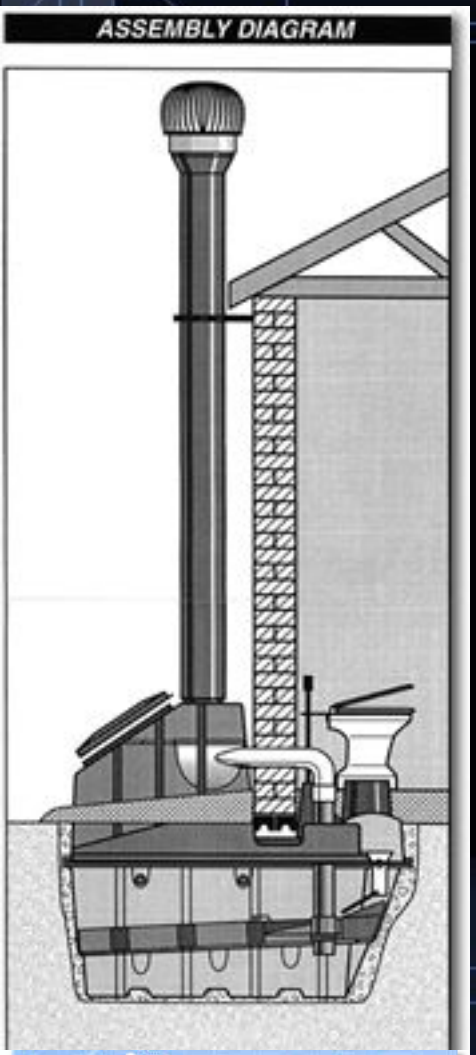
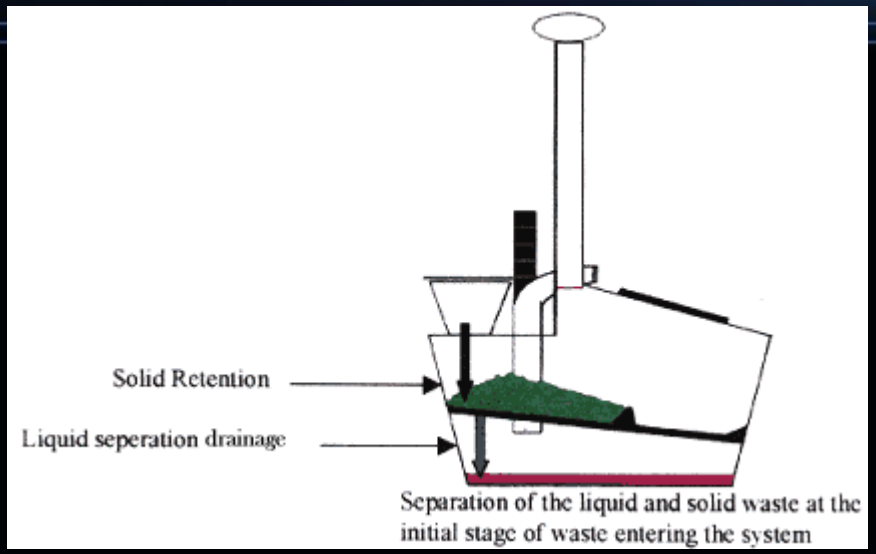
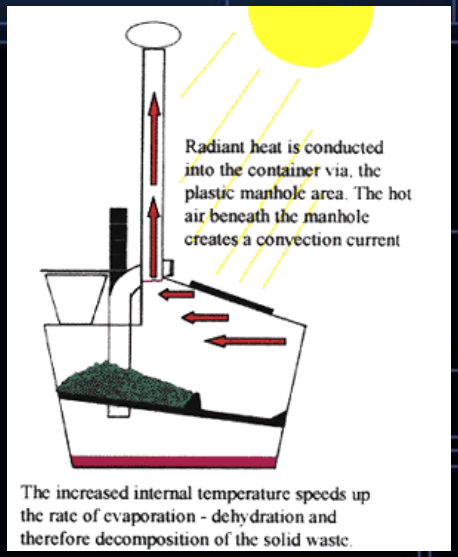
Dehydration system

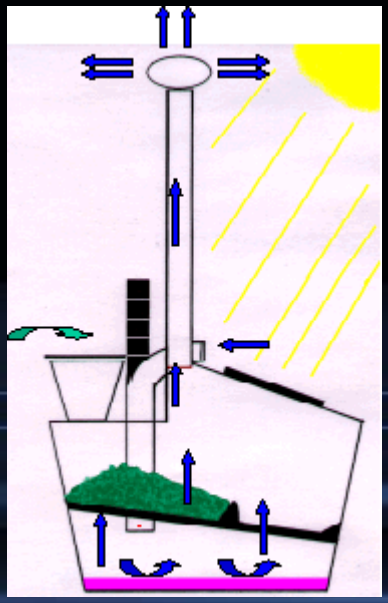


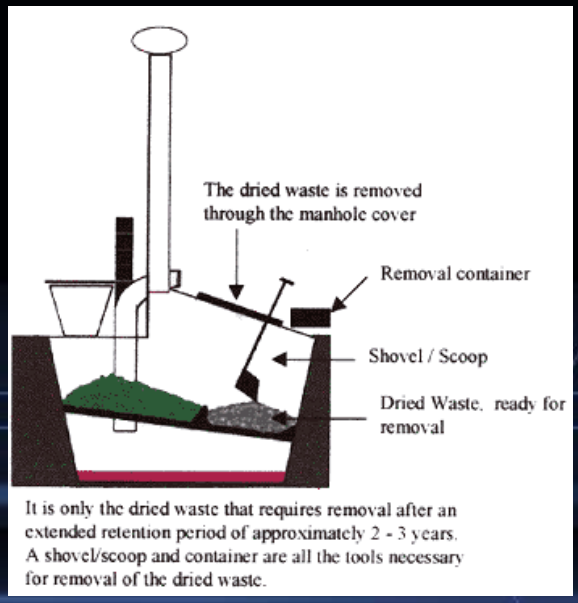


Separation of the liquid and solid waste at the initial stage of waste entering the system



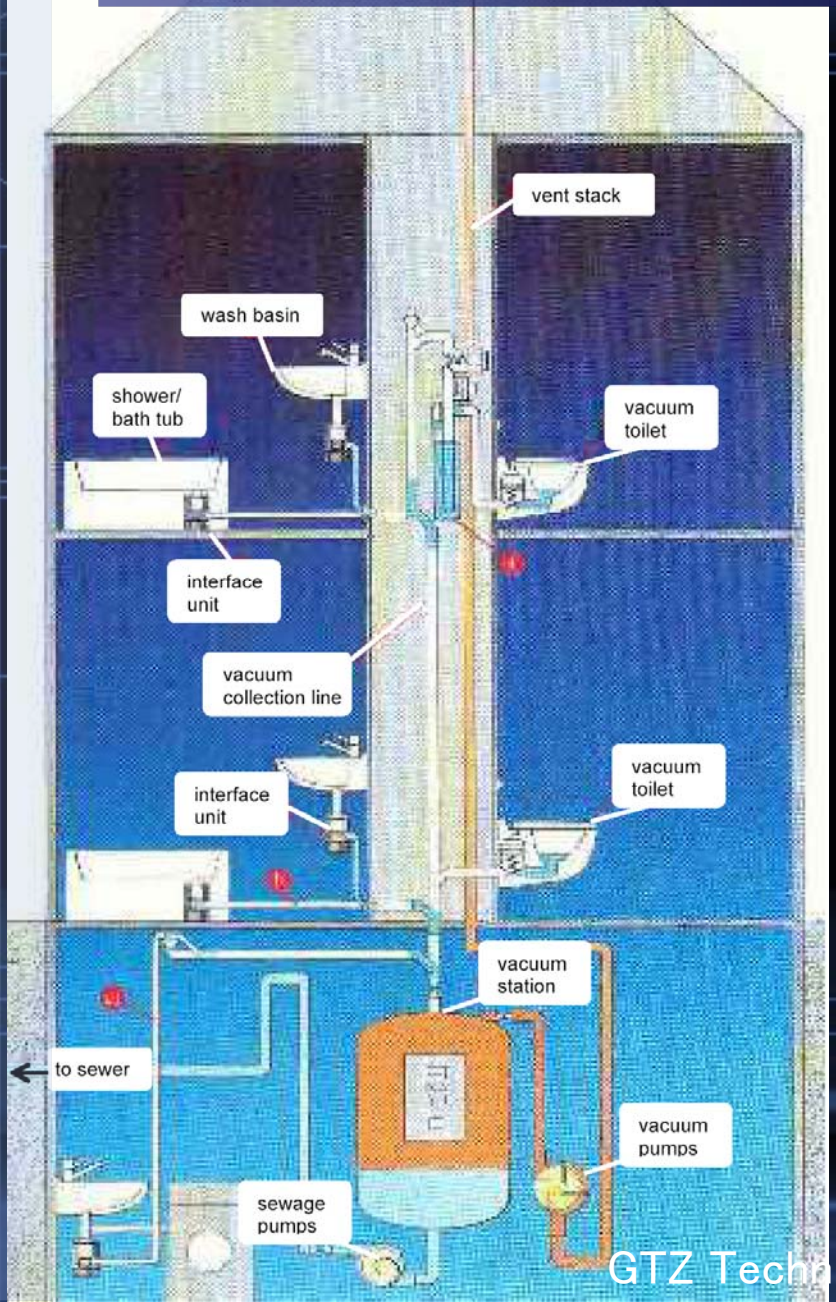
The increased internal temperature speeds up the rate of evaporation - dehydration and therefore decomposition of the solid waste.

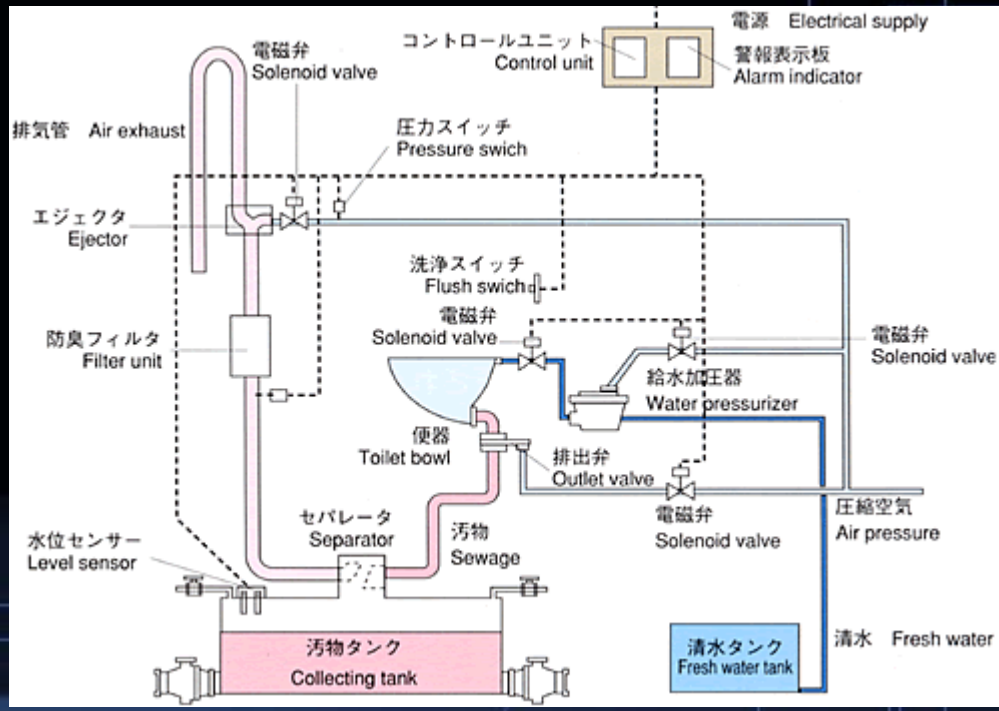




It is only the dried waste that requires removal after an extended retention period of approximately 2 - 3 years. A shovel/scoop and container are all the tools necessary for removal of the dried waste.

Vacuum system





五光製作所
http://www.go-ko.co.jp/products/index.html

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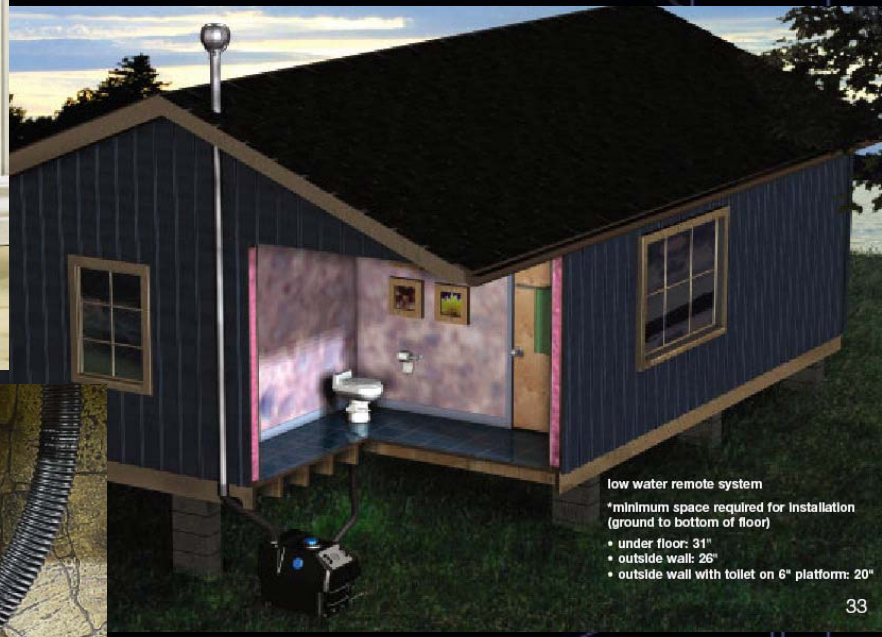
Vacuum system（市販品）

	Components	Features
Vacuum Toilets	JETS 50 EFD 	▪ 20,2 kg to 22, kg ▪ wall or floor mounted ▪ electrical operation ▪ vitrous china, sanitary porcelain ▪ 0,5 l to 1,5 per flush ▪ 350 - 450 EUR
	JETS 60 EFD 	▪ for ships ▪ 19 kg ▪ stainless steel ▪ X EUR
	JETS Squat pan 	▪ stainless steel ▪ x EUR
	ROEDIGER 	▪ tube valve ▪ wall or floor mounted ▪ pneumatic operation ▪ porcelain ▪ 0,7 l per flush ▪ 590 - 645 EUR
	EVAC 900 	▪ wall or floor mounted ▪ pneumatic operation ▪ sanitary porcelain ▪ 1,2 l per flush ▪ x EUR
	EVAC 90 squatting plate 	▪ 1,5 l to 2,5 l per flush adjustable ▪ stainless steel ▪ 1600 EUR
	EVAC 90 kandre 	▪ shock and vibration proof ▪ navy/military design ▪ 1,2l per flush ▪ x EUR

Composting Toilet



envirolet™

Envirolet® Composting Toilet Systems

1-800-387-5126
416-299-4818

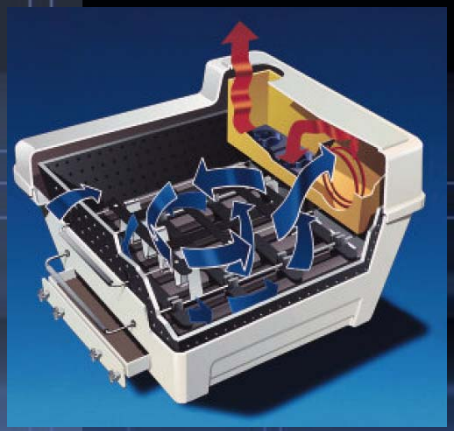
www.envirolet.com
info@envirolet.com

Composting Toilet

Specifications

MODEL	POWER	POWER MIN.	POWER MAX.	WEIGHT (LBS.)	CAPACITY* VACATION	CAPACITY* FULL-TIME
Waterless Self-Contained						
Envirolet® Basic Plus	Non-Electric	N/A	N/A	75	4	2
Envirolet® DC12	12VDC Battery	0.3A	0.6A	88	6	4
Envirolet® MS10	120VAC Electric	40W	540W	88	8	6
Waterless Remote						
Envirolet® W/RS NE	Non-Electric	N/A	N/A	110	6	4
Envirolet® W/RS 12VDC	12VDC Battery	0.3A	0.6A	118	8	6
Envirolet® W/RS 120VAC	120VAC Electric	40W	540W	120	10+	8
Low Water Remote						
Envirolet® LW/RS NE	Non-Electric	N/A	N/A	130	6	4
Envirolet® LW/RS 12VDC	12VDC Battery	0.3A	0.6A	138	8	6
Envirolet® LW/RS 120VAC	120VAC Electric	40W	540W	140	10	8

*Capacity: Number shown is persons per day. Persons per day rating is based on three uses per person per day. All systems will handle occasional additional use.



Envirolet® composting toilet systems are designed and engineered around our unique, patented, Automatic Six-Way Aeration™ and evaporation process. Up to 90% of waste is water. Envirolet® eliminates the liquid and the remaining 10% is converted into a clean, dry compost. To do this, Envirolet® perates in conjunction with natural microbe action while dual fans continuously circulate a large volume of air, at a high flow rate, around a specially shaped Aeration Basket that maximizes waste surface area for better efficiency.

Composting Toilet

The Phoenix is fabricated from rotationally molded solid and foamed **crosslinked and linear polyethylene,** assuring many years of service. The tank is durable, corrosion resistant, leakproof, and continuously insulated.

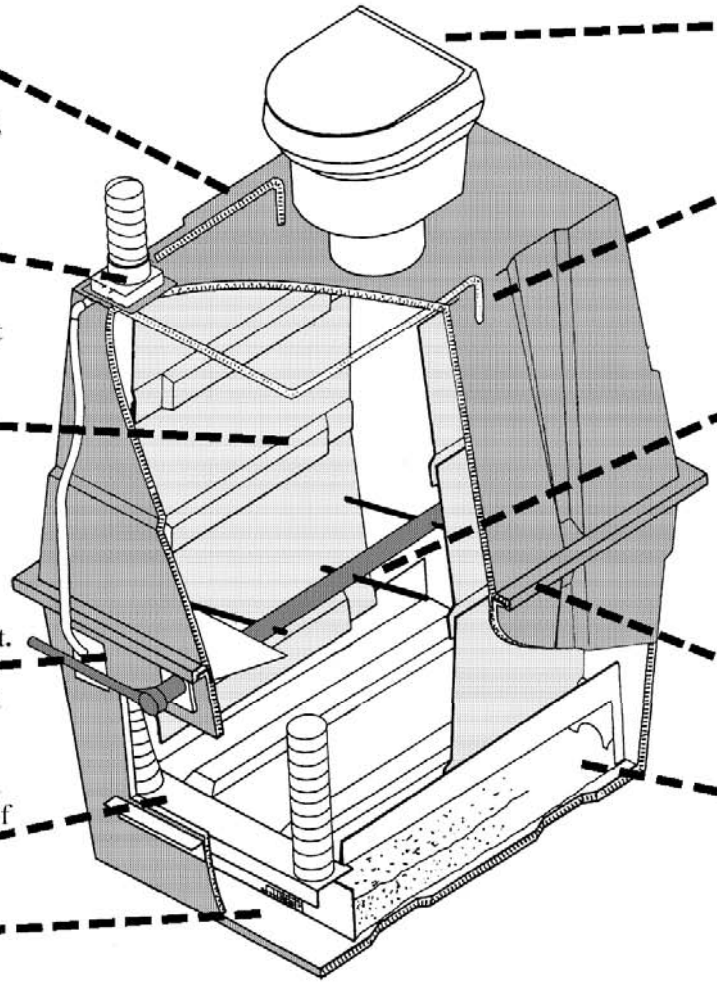
Ventilation is provided by an efficient, 4-watt, direct current fan. The fan housing is mounted directly to the tank for easy maintenance. A small power supply or a photovoltaic system provides the energy. Flexible 4-inch duct and 4-inch PVC pipe are installed easily.

Continuous air baffles along the tank sides provide **aeration** of the compost pile without interfering with compost movement. Their large surface area allows the insulated tank to be readily warmed with circulating air from a heater or active solar collector.

Air enters the Phoenix through a **screen inlet.** A **sealed path** for ventilation air, and a large contact area, increase ventilation efficiency and allow supplemental heating.

Finished compost is **removed easily** through the **lower access door** from the entire bottom of the Phoenix assuring maximum and uniform retention time.

Liquid is separated from the solids by a **screened baffle** and resprayed, or drained, from the Phoenix. The **drain connection** can be made from either side through an inch-and-a-half flexible hose.



One or two **toilets** connect to the Phoenix with 12-inch diameter pipe. The toilets are molded from **vandal resistant polyethylene and ABS plastic.**

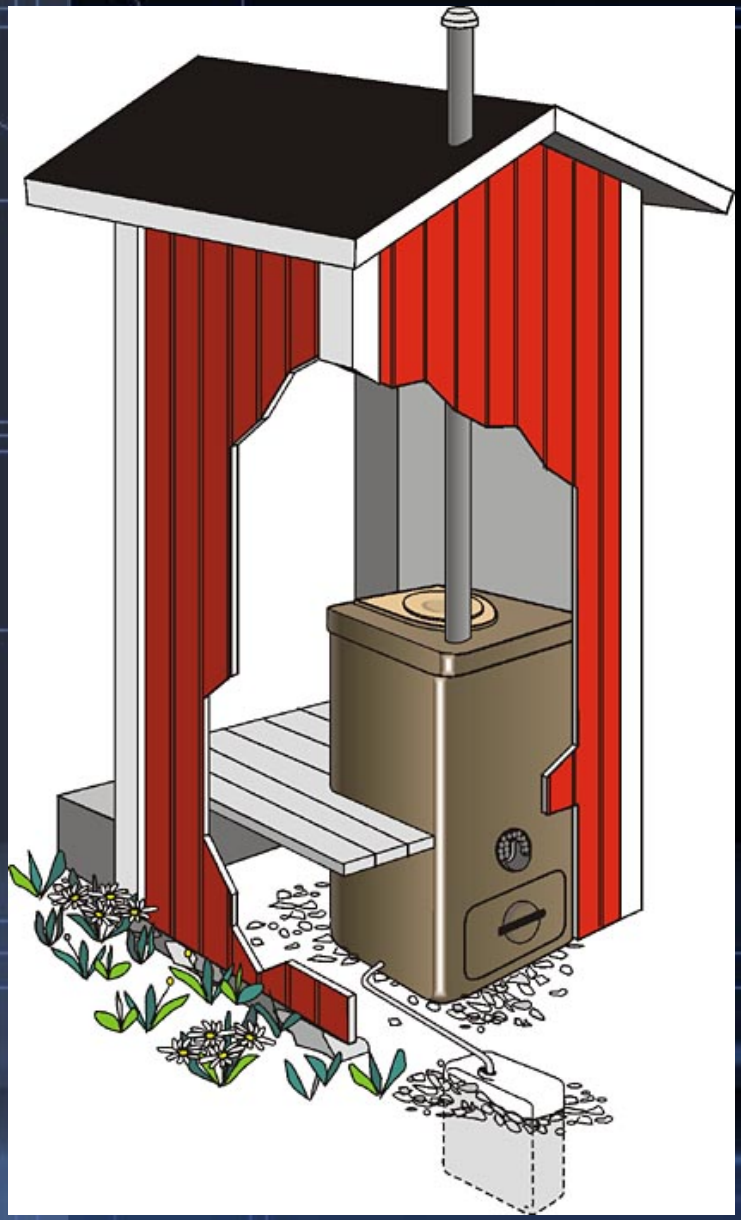
The accumulated liquid and/or fresh water is automatically **resprayed** on top of the compost pile to **maintain moisture** and inoculate the pile with compost-friendly micro-organisms. The excess liquid is drained to a leach field, or an evaporation or holding tank.

Rotating tines control the downward movement of the material in the compost pile. The big Phoenix Model 201 has three tine shafts, each above the other. The Model 200 (shown) has two shafts, and the Cabin model has one. (For clarity, only one tine shaft is shown in this illustration.)

A **leakproof joint** is accomplished with a gasket and **interlocking flange.** Assembly requires only a few bolts and no caulking.

A **permanent medium** provides **secondary liquid treatment** beneath the sloped bottom baffle. Air travels over the entire surface of the liquid to increase evaporation and aerobic conditions.

Composting Toilet



Bed material

dried coniferous tree-bark and peat

Accelerator

bone powder, horn shavings, crushed seaweed, composted chicken manure and bentonite clay

BIOLAN®

Finland

Composting Toilet

coarse peat moss and chopped hemp stalk

enzyme

bacteria

SUN-MAR

USA/Canada

Composting Toilet

日本ではおが屑を使用し、”バイオトイレ” と称されることが多い

バイオトイレ呼称

正和電工	北海道	http://www.seiwa-denko.co.jp/
環境シーエスワン	新潟	http://www.ecs1.co.jp/bio/
サンバイオ	北九州	http://www.sunbio.net/index.html
大央電設工業	長野	http://www.daiobio.co.jp/index.htm
バイオセレント	東京	http://www.bioselent.com/company.html
山佐木材	鹿児島	http://www.woodist.co.jp
ミカサ	大分	http://mikalet.jp

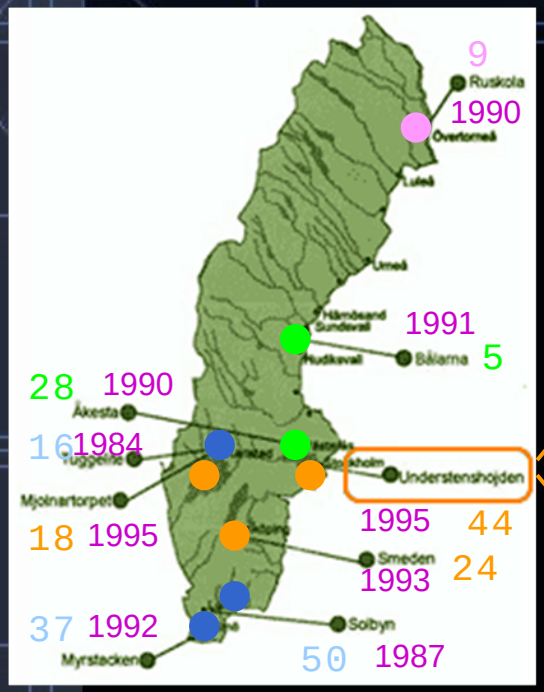
コンポストトイレ呼称

エコライフクリエイト	愛知	http://www.jin.ne.jp/e-create/index.html
コスモエース工業	東京	http://www.kosumo-a.co.jp/kaisha_001.htm

どこに適用すべきか？

- 北欧などでの取り組みがさかんなのは何故か？
- 発展途上国において導入する際に問題となることは何か？

Eco villagge in Sweden



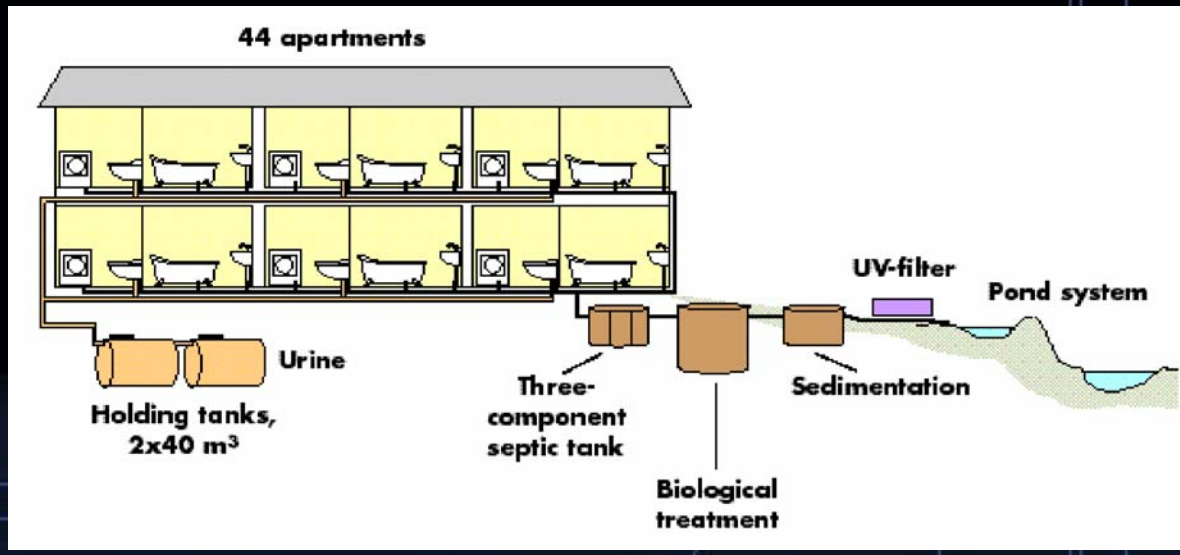
9つのEco Village

Urine separation

Composting Toilet

Double toilets for urine and feces

Infiltration

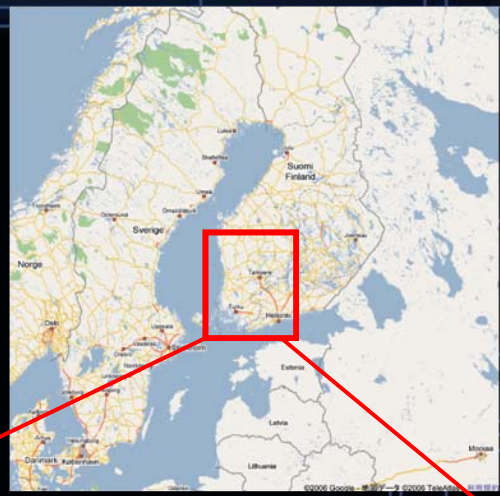


Wastewater treatment system at Understenhöjden ecovillage, Sweden

from GTZ Technical data sheet

from Ecoby Org [http://www.ekoby.org/index.html]

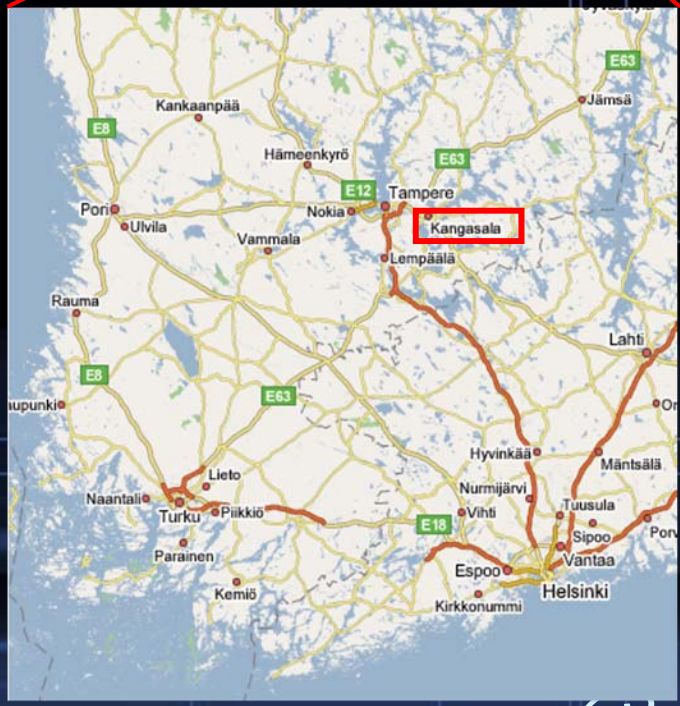
Finlandの事例：Eco Village



9 households

urine separation

composting

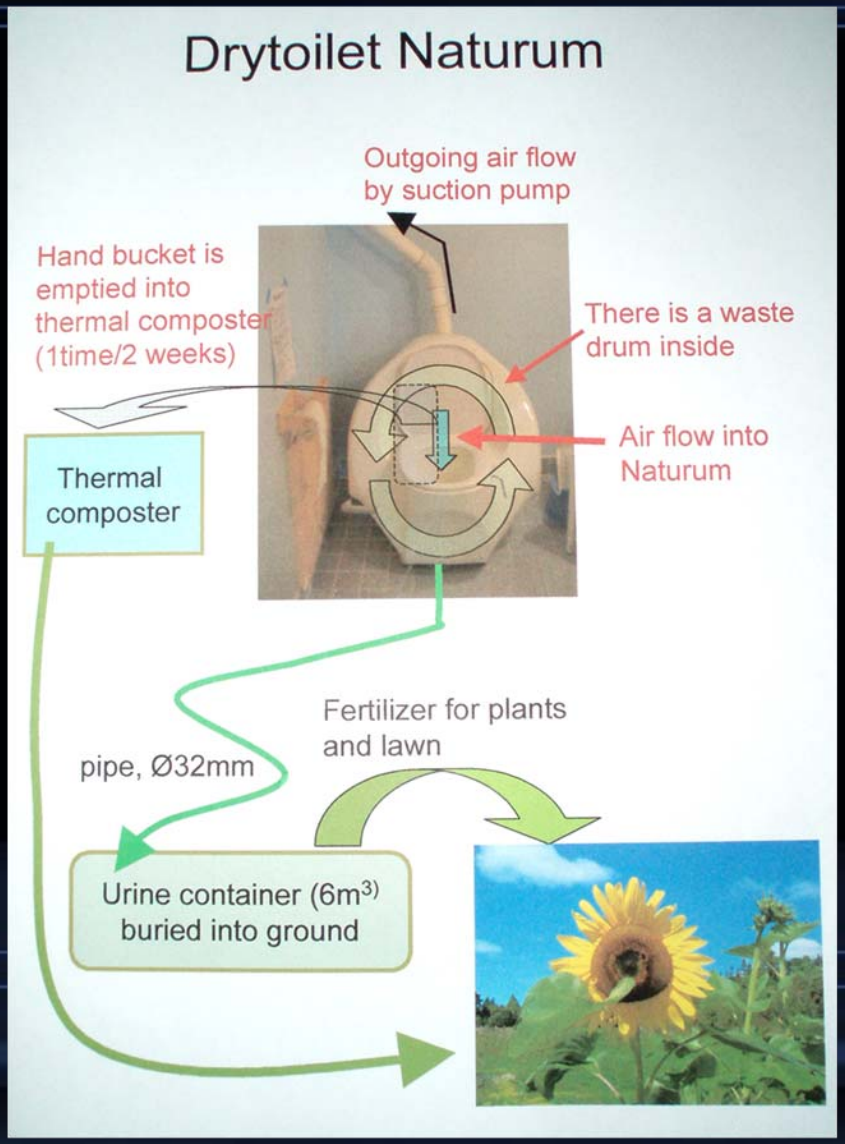


Finlandの事例：Eco Village






Finlandの事例：Eco Village



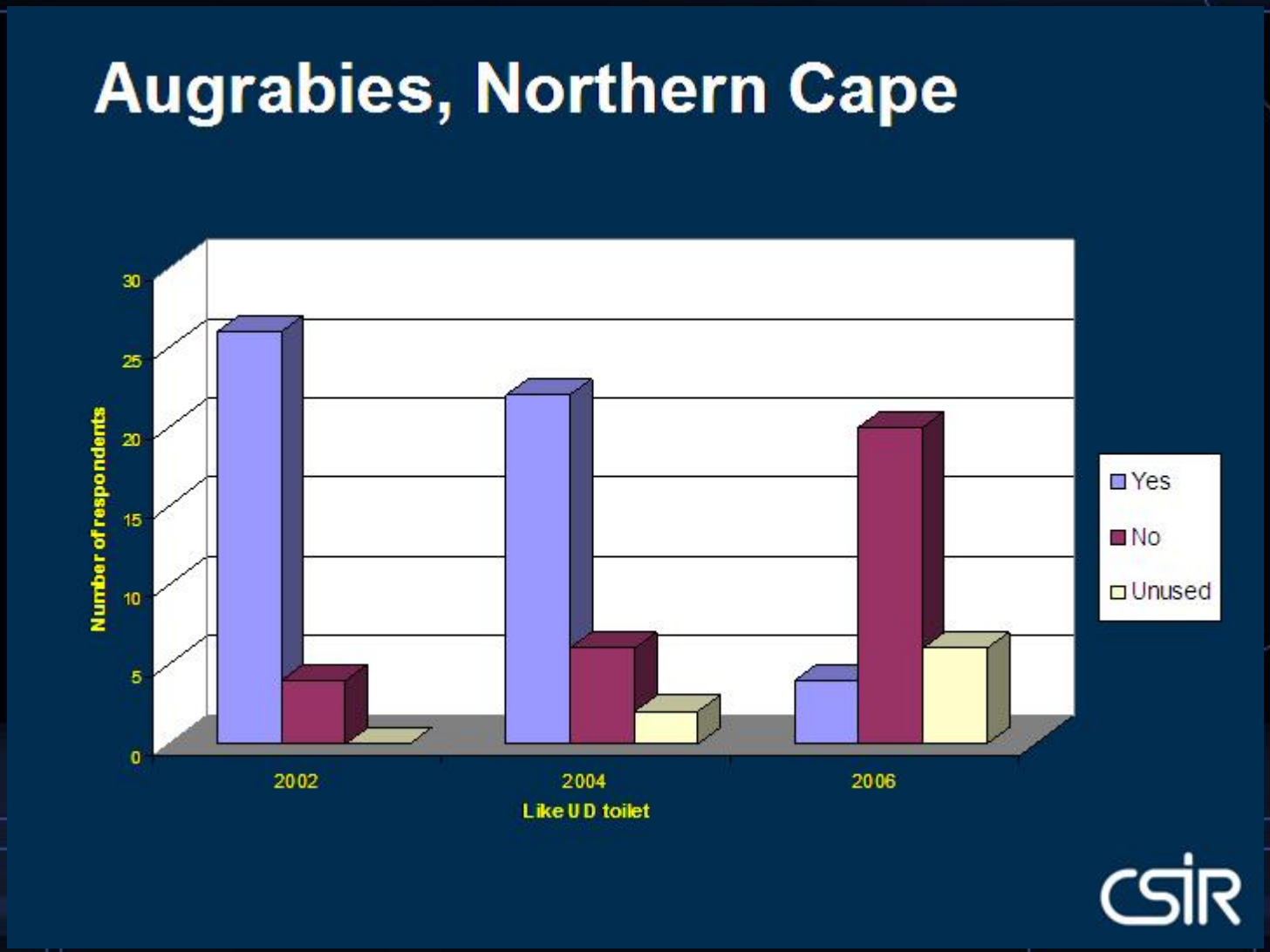
・取り組みは理念的

・多くの作業を自分で行なわなければならないが、その手間を厭わない理念的motivationが存在している

→全ての人に適用できるわけではない

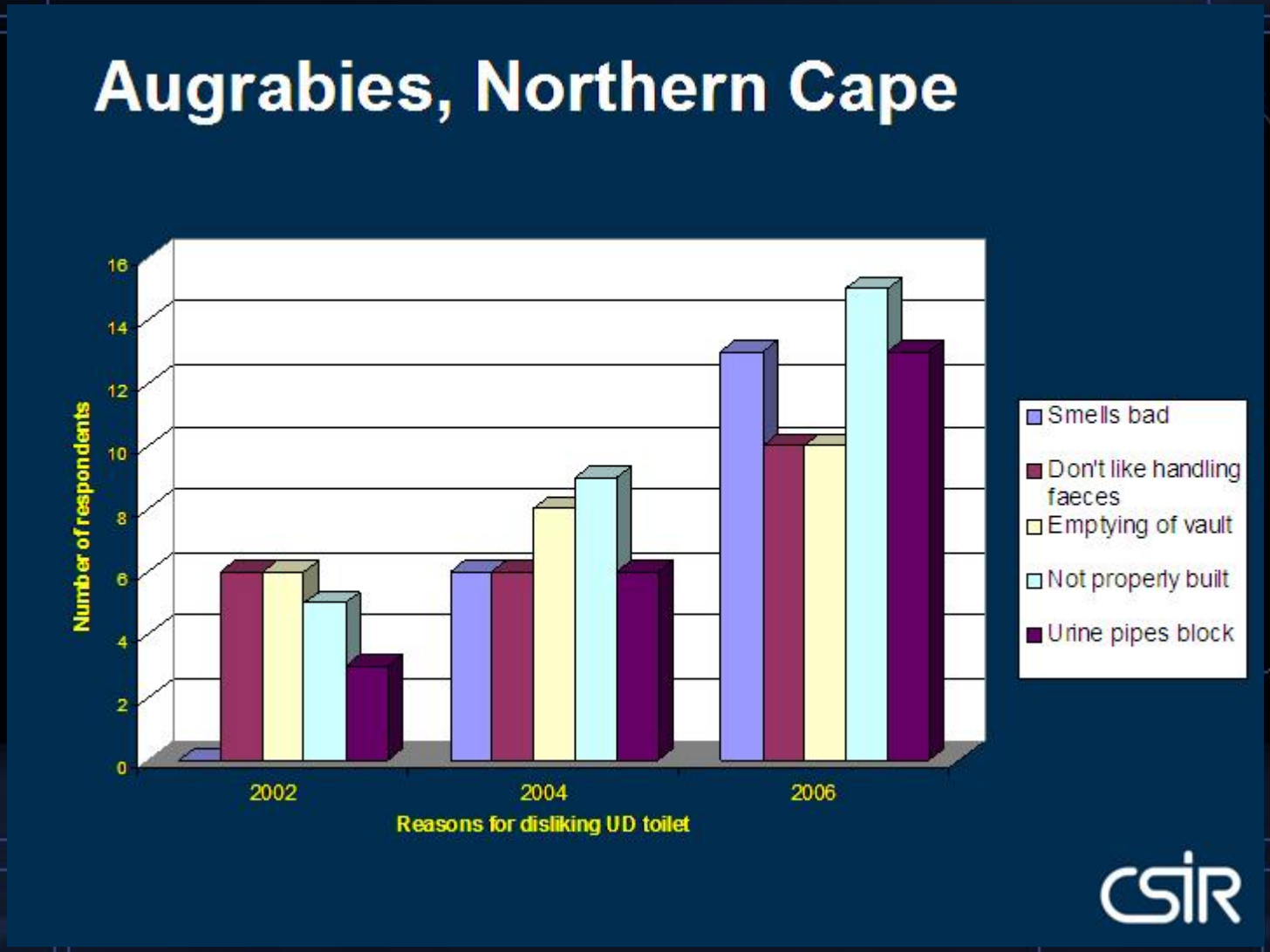
→South Africaの事例

発展途上国への適用困難性



from Dry Toilet Conference
Session 3

発展途上国への適用困難性

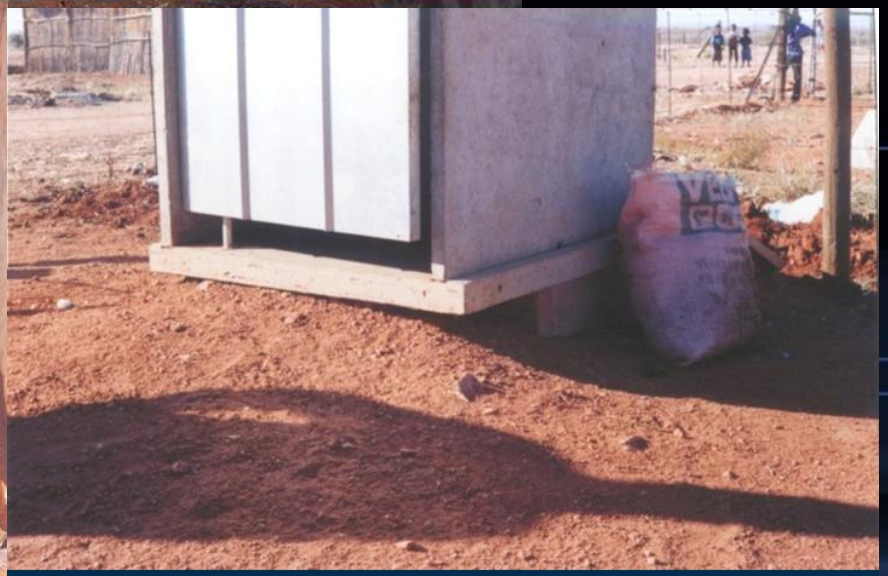


発展途上国への適用困難性

- 継続性を持たせるだけのシステム設計
- 現地住民への教育及びトレーニング

が必要

from Dry Toilet Conference Session 3



Constructionの不備