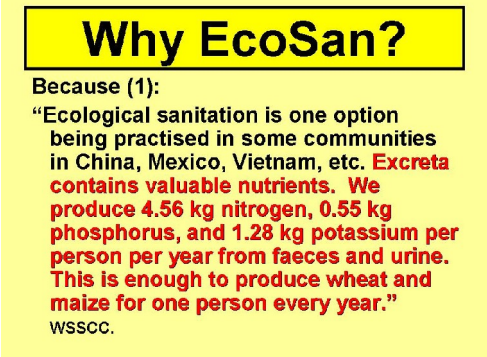
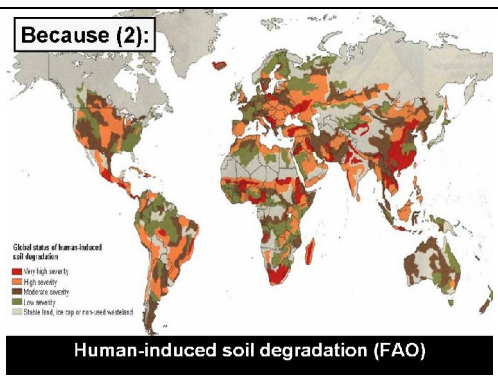
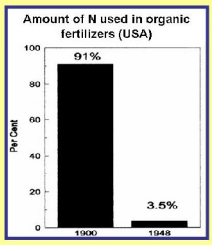
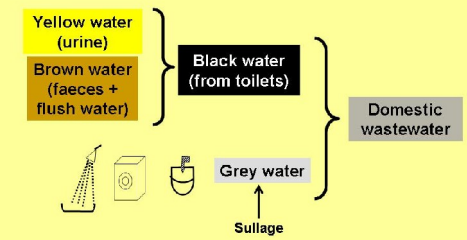
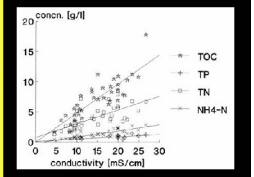
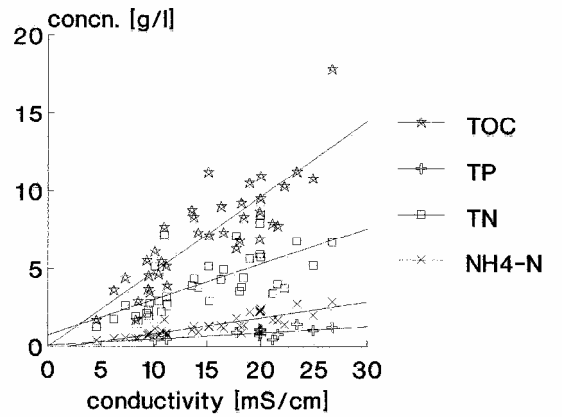
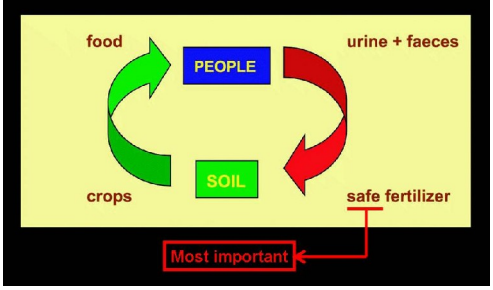
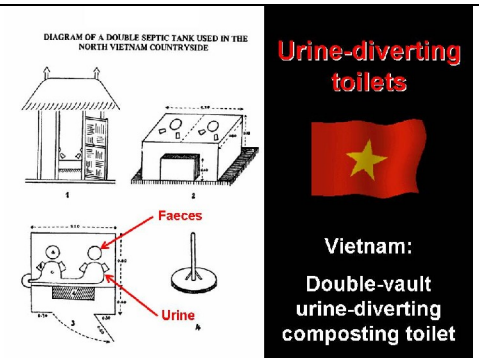
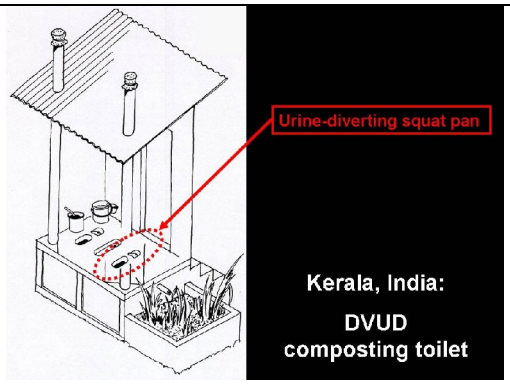
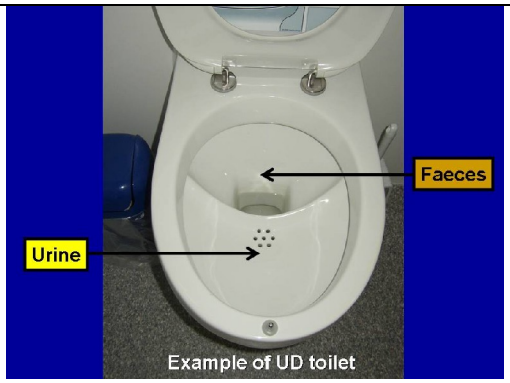
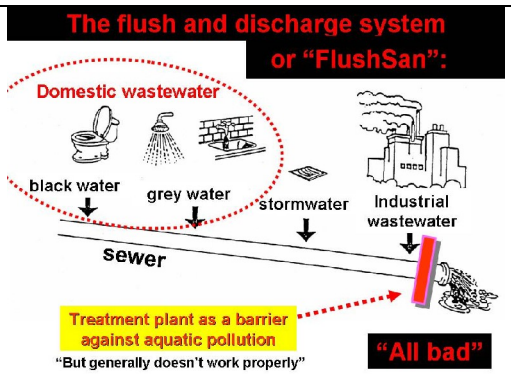
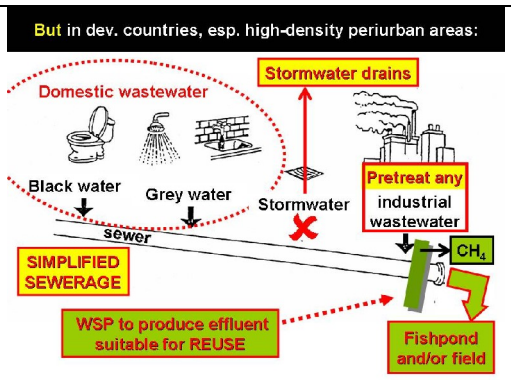
Ecological Sanitation

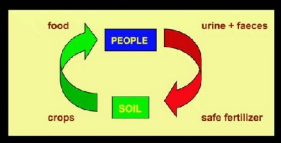
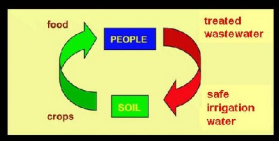
1.		This presentation is on 'Ecological Sanitation', which has the following basic principles:
2.		The **nutrients in human excreta** − nitrogen, phosphorus and potassium − should be used, not wasted or allowed to pollute the environment; the excreta should not be diluted with water − such as toilet flush water or sullage (which is also called 'greywater'); and, as urine is the major source of our excreted nutrients, it should be isolated or 'diverted'.
3.		So, why EcoSan? Firstly because we each produce around 4.56 kg of nitrogen, 0.55 kg of phosphorus and 1.28 kg of potassium in our excreta every year, and this is more or less what is needed to produce the basic carbohydrate, such as wheat, maize or rice, for one person for one year.
4.		Secondly, because, as shown in the slide, there is a lot of **human-induced soil degradation** in many parts of the world, and this situation is getting worse, not better, year on year.

5.	Because (3): ➢ Nutrients in human excreta generally wasted (and they cause eutrophication) ➢ Artificial fertilizers almost exclusively used in industrialized countries, but expensive for poor subsistence farmers in developing countries 	And thirdly, because we generally waste the nutrients in our excreta and they can cause severe environmental problems, for example eutrophication. In industrialized countries farmers almost exclusively use artificial fertilizers, but these are commonly too expensive for farmers in developing countries, unless they are massively subsidized by the government. The chart on the right shows how artificial fertilizers have taken over in the United States. A hundred years ago just over 90% of the nitrogen applied to crops came from organic fertilizers (manures, for example), but by 1940 this had dropped to 3.5%.
6.	**Domestic wastewater is a mixture of:** 	Now domestic wastewater is a mix of 'yellow water' (that is, urine), 'brown water' (faeces and any flush water), and 'grey water' (or sullage, that is all the wastewater from sinks, baths and showers, the non-toilet wastewaters). If yellow water and brown water are mixed together, the resulting mixture is called 'black water'.
7.	**Volumes of wastes** Litres per person per year: 1. Brown water: ~50 2. Yellow water: ~500 3. Grey water: ~10,000–100,000 – ie, domestic wastewater volume of ~30–275 litres per person per day	And this is how much we produce of each of these waters, in litres per person per *year*: brown water, ~50; yellow water, ~500; and grey water anywhere between 10,000 and 100,000. So we're talking about a domestic wastewater volume of between ~30 and 275 litres per person per *day*.
8.	**NPK in waste streams** kg/person yr: Brown Yellow Grey N ~4.5 ~10% ~87% ~3% P ~0.75 ~40% ~50% ~10% K ~1.8 ~12% ~54% ~34% [COD ~30 ~47% ~12% ~41%]	This slide shows where the nutrients, the NPK, are in our waste streams. Urine, yellow water, has most of the nitrogen and just over half the potassium; and black water, yellow and brown waters together, has 90% of the phosphorus.

9.	**Concentrations in urine vary, depending on amount of liquid intake and losses due to sweating** Typical concentrations: Total N: ~3.5 (± 1.2) g/l Total P: up to 1 g/l Total organic C: ~6.5 (± 2.8) g/l  ►*Enlarged version of chart on right:* 	Of course, the concentrations in yellow water, urine, vary quite a bit as they depend on how much a person drinks and how much he or she sweats; but typically urine contains ~3.5 g total N per litre and up to 1 g P per litre. The chart on the right shows that we can get good estimates of the concentrations of total N, ammonia N, total P and total organic carbon simply by measuring the electrical conductivity of urine.
10.	**Urine has most of the NPK** Therefore **don't mix it** **with brown or grey waters** **Urine diversion (or separation) is a basic principle of EcoSan**	So, urine has most of the NPK we excrete, and we shouldn't mix it with brown or grey waters. This is a central tenet of EcoSan, although some EcoSan proponents are not quite this orthodox. Thus, for many EcoSan proponents, 'urine diversion', sometimes called 'urine separation', is a fundamental principle of EcoSan.
11.	**EcoSan "closes the loop"**  	EcoSan "closes the loop" between our excreta and our food. It's simply direct reuse of the nutrients in our excreta by making sure that excreted pathogens are dead, so the process is safe. It's human excreta → made into safe fertilizers → which are applied to the soil → to fertilize crops → to produce food → for us.

12.		This slide shows a double-vault urine-diverting composting toilet which has been extensively used in the north of Vietnam since the 1950s. The double-vault system is identical in operation to the alternating twin-pit system used with VIP latrines and pour-flush toilets.
13.		And this slide shows a similar DVUD toilet from Kerala in India.
14.		And this is a model of a DVUD toilet used in China, where a commercially available ceramic urine-diverting squat-pan is used.
15.		This slide shows a urine-diverting pedestal-seat toilet developed in Germany.

16.	   A Urine-diverting pedestal unit from South Africa B Urine-diverting squat-pan from China C Urine-diverting porcelain unit from Sweden	Here we have three urine-diverting toilets: one from South Africa, top left, and this is similar to the ones used in the alternating twin-vault VIV latrines in eThekwini; top right is the Chinese ceramic squat-pan; and bottom left is a ceramic unit from Sweden.
17.	**Applicability of EcoSan** • Clearly applicable in rural areas where people want to use, or have a tradition of using, excreta for crop fertilization. • Now becoming increasingly and *very* enthusiastically recommended for towns and periurban areas (OK if people want to use urine and composted faeces locally, or can sell both to local farmers – but outside Asia this might be difficult to organize). • **Be careful: "powerful" arguments used – eg:**	EcoSan is clearly applicable in rural areas where people want to use, or have a long tradition of using, human excreta for crop fertilization – for example, parts of China and Vietnam. EcoSan is now being very enthusiastically recommended for towns and periurban areas, but it's not always clear that local people want to separate and use urine, or indeed use composted faeces; of course, if they do, then fine, but you really need to find out first. Quite powerful arguments are used against sewerage (of any type) and thus for EcoSan. For example,…
18.		the 'flush and discharge' system or 'FlushSan' is often portrayed like this. All the separate waste streams (the yellow, brown and grey waters) are mixed together and discharged into a sewer. The sewer also receives untreated stormwater and often untreated industrial wastewaters as well. The treatment plant, if of course there is one, generally doesn't do a good job, so the receiving water becomes badly polluted. So it's "All Bad".
19.		Actually it's not 'all bad' at all. You can use simplified sewerage to reduce costs; you can prevent stormwater entering the sewer (and this is very commonly done anyway in developing countries where it's usual to see stormwater drains in urban areas); and you can insist that industrial wastewaters are treated prior to discharge (and you can do this very effectively by a trade waste tariff structure that charges a lot for untreated wastes and much less for treated wastes, so that it becomes financially attractive to treat the waste before discharge to sewer). Then you can treat the wastewater in waste

		stabilization ponds, and at large works you can recover methane from the anaerobic ponds; and finally you can reuse the pond effluent in aquaculture and/or agriculture.
20.	**Sewerage** **+ wastewater treatment** **+ biogas collection** **+ aquacultural and/or agricultural reuse** **is as ecological as EcoSan!**	So really sewerage + wastewater treatment + reuse is as ecological as EcoSan.
21.	**EcoSan may close the loop,**  **but so does wastewater reuse**  	EcoSan may 'close the loop', as we saw earlier, but so does wastewater reuse.
22.	**C O S T S** **India:** Sanitation technology / Construction cost (INR, 20 April 2004*) VIP latrine: 2,150 Single-pit PF toilet: 1,900 Alternating twin-pit PF toilet: 2,500 EcoSan toilet**: 4,200 Source: www.toiletsforall.org *Exchange rates, 20 April 2004: INR 1000 = USD 23 = EUR 19. **Without urine diversion.	One big problem with EcoSan is its **costs**. EcoSan toilets are more expensive than other on-site sanitation systems, as shown in this slide which gives construction costs in India as of April 2004. An EcoSan toilet without urine diversion costs over twice as much as a single-pit pour-flush toilet, so why would a poor rural family in India choose an EcoSan toilet?
23.	**C O S T S** **South Africa:** Sanitation technology / Construction cost (ZAR, 2002*) Single-pit VIP latrine: 600–3000 Single-pit PF toilet: 2000–3000 Simplified sewerage: 2500–3000 EcoSan toilet**: 3000–4000 Source: South African Dept of Water Affairs & Forestry *Average 2002 exchange rates: ZAR 1000 = USD 87 = EUR 100. **With urine diversion.	And this slides tells the same story for South Africa. The construction cost of a single-pit VIP latrine in 2002 was much cheaper than an EcoSan toilet with urine diversion, and so presumably rural families would choose the former, not the latter. And high-density periurban communities would choose simplified sewerage, not EcoSan, for the same reason.

24.	**EcoSan costs (USD) per household in urban areas of the nine UN regions of the world** Sub-saharan Africa $350 Southern Asia $440 East Asia $650 Eurasia $725 Southeast Asia $800 Oceania $875 North Africa $900 Latin America & Caribbean $1000 West Asia $1200 *Source:* Stockholm Environment Institute (2005).	These EcoSan costs, taken from a 2005 report by the Stockholm Environment Institute, are for urban areas in the nine United Nations regions of the developing world. As you can see, they are really very high indeed.
25.	**So there's a big**  **over EcoSan**	There are many EcoSan projects around the world, but in developing countries there's usually a massive subsidy[*] which pays for most, if not all, of the construction cost of an EcoSan toilet. But so many people require improved sanitation if we're to meet the MDG sanitation target by the end of 2015, that there won't be the money available to subsidize all EcoSan toilets. This means, to my mind at least, that, simply on the grounds of cost, there a big, in fact a very big, question mark over ecological sanitation. [*] Usually provided by a bilateral aid agency.