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With kind permission of the Director of the Centre for Science and Environment, New Delhi, India and the author of the article: Sunita Narain

# The flush toilet is ecologically mindless



**Think about it.**

**SUNITA NARAIN**

While attending the Stockholm Water Symposium a few years ago, my colleague, Anil Agarwal, and I were invited to a banquet by the king of Sweden. But instead of dining in splendour we were checking out toilets in some remote parts of the city. I was not too convinced of our mission. We opened the hatch of "alternative" toilets bins, where the faecal matter is stored before composting. We were regaled with information about how urine could be separated in the toilet and used directly for agriculture. Our friend, Uno Winblad, toilet crazy like Anil, then took us to supermarkets in Stockholm city where there were a range of toilets — from water-saving to electric and of course, urine separating toilets. Anil, who hated shops, was delighted. And I began to understand the links.

The flush toilet and the sewage system —

which I always believed embodied personal hygiene and environmental cleanliness — are a part of the environmental problem and not the solution. I began to understand from our research that this technology is quite simply ecologically mindless.

Consider the large amount of clean water that is used to carry even a small quantity of human excreta. In India, flushes are designed to be particularly water-wasteful. So with each flush, over 10 litres of clean water goes down the drain. We build huge dams and irrigation systems to bring water to urban areas. This water which is flushed down the toilet goes into an equally expensive sewage system, all to end up polluting more water — invariably our rivers and ponds. Most of our rivers are today dead because of the domestic sewage load from cities. We have turned our surface water systems into open sewage drains.

This heavy use of surface water is leading to growing conflicts between urban and rural

users and also to overexploitation. Moreover, the discharge of domestic sewage is leading to heavy pollution of rivers and urban groundwater aquifers.

The present strategy is to invest in huge river clean up programmes like the Ganga Action Plan, the Yamuna Action Plan or the National River Action Plan to treat sewage. These expensive river action programmes are sanitary engineers' dreams. The aim is to divert sewage, which earlier flowed directly into the river, to a treatment facility. This sewage, incidentally, comes from the flush toilets of the rich, not the poor.

This is what Anil called the political economy of defecation. The more water you use, the more investment is needed to clean it up.

The political economy of sewer systems is simply atrocious for developing countries. Hardly any poor city is able to recover its investments in sewer systems. As a result, the users of these sewer systems get a subsidy. But almost all users in poor cities are the rich. Thus, sewers only lead to a subsidy for the rich to excrete in convenience. The poor always remain the 'unserved' in this waste disposal paradigm. In addition, the government has to invest in sewage treatment plants whose costs are again rarely recovered from the rich users of flush toilets.



**Sewers cost the earth**

It is virtually impossible for governments to catch up with the targets of building sewage treatment plants. Government programmes chase targets hopelessly and remain miles behind the volume of sewage being generated. In a rapidly urbanising situation,

the city would soon outgrow the sewage treatment capacity created at a high cost. Further investments would be needed all over again.

### **Understand the political economy of defecation**

Take Delhi, as a typical instance. Yamuna is Delhi's main sewage drain. Yamuna enters Delhi at Wazirabad — where the city draws its water supply — and after this an estimated 1,800 million litres per day (MLD) of untreated sewage flows through 18 drains into the river. In the last four decades, the total sewage output has increased rapidly. Untreated sewage has grown even faster. In 1999, the Central Pollution Control Board estimated that Delhi produces over 2,547 MLD of sewage of which only 885 MLD is collected through the sewage network for treatment and the bulk — over 75 per cent flows into stormwater drains and then into the river. By late 2000, treated sewage had increased to 1,333 MLD as had the quantity of sewage — still over 50 per cent of the city sewage was dumped into the river. By 2005, Delhi plans to triple its present sewage treatment capacity at a cost of Rs 750 crore. But this will still be less than what is needed.

### **Paradoxical chase**

It is an ironic situation. Even if Delhi builds all the sewage treatment plants, it will still not have the sewage to treat. Why? The city's sewage drains are choked and silted. The government admits that the present capacity of the sewage treatment plants is not being utilised and when it builds new treatment facilities, sewage never reaches these plants.

On the other hand, sewage from these choked and broken lines is diverted to functioning lines and, as a result, the treatment plants at the end of these lines are overloaded leading to untreated sewage flowing into the river. While some plants are overloaded, others are underutilised. The bill

to refurbish the sewers is around Rs 500 crore, according to the government. Over and above this is the capital cost of the new sewage treatment plants.

Moreover, this is the cost of maintaining and running sewage plants and ensuring that the released effluent meets quality standards. Even if the government were to bear the full capital costs of sewage treatment plants, few urban municipalities have the financial resources to bear the expensive operating costs. As a result, sewage treatment plants, even when built, often lie idle.

In urban areas, drinking water is a small component of the total water use. It is sewage and other waste disposal needs that require maximum water input. This huge demand for water for our cities comes at very high political cost as conflicts between urban and rural users for water are reaching flashpoint

### **A tale of two cities**

The water culture of people is an important indicator of their level of civilization. Take the two ancient cities, Rome and the town of Edo, which grew into the mega-metropolis of Tokyo. The people of Rome brought their drinking water with the help of long aqueducts, which today are regarded as architectural marvels of the bygone Roman civilisation. But the people of Rome lived on the banks of the river Tiber. They didn't need to bring water from afar. Unfortunately, they did not know to dispose of their human wastes and like the modern Western civilisation they ended up polluting the river, thus being forced to go far in search of clean water. This makes Roman aqueducts not a symbol of intelligence but one of great environmental stupidity.

On the other hand, Edo, which too was situated on several streams, ensured that all its human wastes were collected and returned to the farmlands. Its neighbouring

rivers remained clean and it tapped its water from them through an extensive piped water supply.

But today we are all children of Rome and not Edo. We have turned our backs to our waterbodies and if we don't have money to clean our mess, then we will have nothing but polluted waters.

### **Paying "full costs"**

Worse, the political economy of defecation is such that no democratic government will accept the hard fact that it cannot "afford" to invest in modern sewage systems for its citizens. Instead, it continues to subsidise the users of these systems, in the name of the poor, who cannot afford these systems in the first place. The cost to build sewage treatment plants is externalised through these environmental programmes. The logical policy would be to accept the cost and then to impose differential pricing so that while the rich pay for the cost of the capital and resource intensive sewage and waste disposal technology, the poor pay for the cost of their disposal system, which is invariably unconnected to the sewerage system and hence low cost.

But this is easier said than done. The "socialist" framework in our country forces political leaders to keep water and waste pricing affordable for large sections of urban populations. In this situation, private investment also looks for an easy way out. Their answer is to invest in water services and leave the costly business of cleaning up the waste to government agencies.

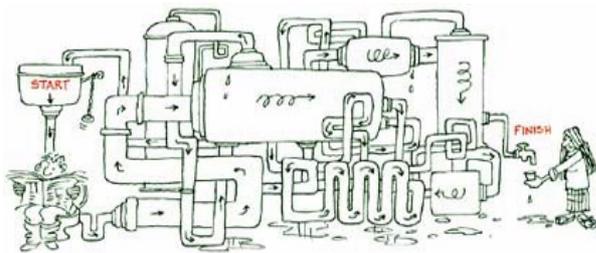
In the meantime, the use of sewer systems would have totally destroyed the aquatic ecosystems in the developing world, posing enormous threats both to public health and aquatic biodiversity. In India, we don't even have to look a few years ahead. We already see the signs of this hydrocide. Literally, no small or medium river today is clean. Every

river that passes through a city or a town becomes a stinking sewer.

### Dirty sewers

Sewage systems are built to protect public health but badly managed sewers can become a serious health hazard. There can be serious outbreaks of waterborne diseases from:

- River pollution because of sewage outfalls;
- Groundwater contamination because of leaky sewer lines;
- Contamination of piped water supply systems because of leaky sewer lines leading to infiltration of pathogens into drinking water pipelines, especially when they do not have water, which is the case in many cities in developing countries as they cannot provide water round the clock; and,
- Sewage backflows because of badly maintained and blocked sewers or because of increasing use of non-biodegradable materials like plastic bags.



Sewers: a subsidy for the rich to excrete in convenience

In the Indian city of Aligarh, sewer lines overflow all the time. A study conducted by the Aligarh Muslim University for the Centre for Science and Environment found that 49-70 per cent of the households, depending on different localities, complained of seasonal or permanent waterlogging due to overflowing sewage drains. As a result, people have raised the plinth of their houses to keep the sewage from flowing into their houses. This

has resulted in a huge market for earth — as much as 1,000 cubic metres per day — supplied today by numerous villages around the city, which is destroying precious agricultural land.

All this makes water-borne sewerage a waste disposal paradigm that is extremely expensive because of its high economic, environmental and public health costs. And as a result, it has very high political costs.

### Going against the laws of nature

Sewer systems totally destroy nature's nutrient cycle in which nutrients collected from the land should be returned to the land. With the use of sewers, this "waste" gets dumped into our aquatic systems. Therefore, while nutrients in food come from agricultural lands, sewage systems dump the nutrients contained in human wastes into waterbodies. Over time, our agricultural lands get depleted of nutrients and need intensive artificial fertilisation. The lack of these micronutrients not only becomes a limiting factor in plant productivity but the resulting lack of these nutrients in human food becomes a threat to human health. By the early 1980s, Punjab had large tracts of land with zinc, manganese and iron deficiency. Ludhiana district, which records the highest yields of many crops, was also recording the highest deficiencies of micronutrients. Though scientists still have to figure out the health effects of consuming micronutrient-deficient foodgrains, scientists at the Postgraduate Institute of Medical Sciences in Chandigarh have found that consuming zinc-deficient foodgrains can lead to retarded growth, defective wound healing and carbohydrate intolerance.

### Paradigm shift

Clearly we need to look for a cost-effective and non-sewerage paradigm of human waste disposal. The capital-intensive, material-intensive urbanisation process of the West works only for rich countries, not poor

countries.

While our scientists think about going to the moon, the toilet is not in their vision at all. There is absolutely no thinking about the need to find environment-friendly sewage systems in our countries. We will need massive investments in r&d for non-sewerage alternatives. While investments in sewers run into billions of dollars every year despite all the problems they create, research investments in non-sewage alternatives hardly exist.

Sewer systems totally destroy nature's nutrient cycle

In this context we need to learn from what is happening across the world. There is a growing concern for ecological sanitation and this is giving rise to innovations from the concept of sewer-less cities using new technological systems which use extremely low amounts of water or no water at all, and, in which all the wastewaters and the solid wastes are recycled.

These modern systems are built on the traditional science of recycling and composting human waste. But in a way that uses the best of modern science and technology to "sanitise" waste and match the convenience and public hygiene of the modern flush toilet.

Therefore, ecological sanitation is a paradigm that we must explore in all earnestness. But we must make sure that the new technologies take into account cultural constraints. Otherwise they are unlikely to succeed.

The most important issue is that these "alternative" technologies must be for the rich and not just for the poor. If ecosanitation technologies are "cost effective" technologies to serve the "unserved" poor, these will only be an interim alternative, one to be discarded as soon as people become rich. We have to remember that it is the rich person's flush that is the biggest environmental culprit today.

## DROWNING IN HUMAN EXCRETA

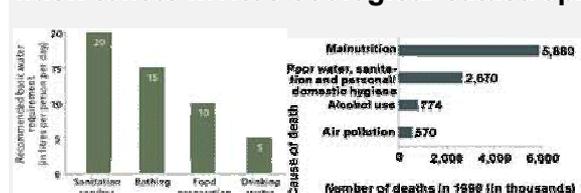


Sanitation for urban India means building flush toilets and linking them to sewer systems. But the price of chasing this dream is leading to an environmental catastrophe. MANOJ NADKARNI analyses our flush and forget mindset

"Don't flush." M K Malhotra, a resident of Delhi's Vasant Kunj, has put this instruction on his toilet. Six members of his family use this toilet at least three times a day and ten litres of water goes down the drain with every flush. In a water-scarce locality, Malhotra can hardly afford this basic sanitation practice. "In fact, it's a luxury," he says.

Malhotra's warning is apt. Flushing consumes maximum amount of water in an average urban household. An ever-increasing urban population — 25.8 million in 1901 to 285 million in 2001 — has thrown up two problems: shortage of water and sewage overload. Malhotra is still fortunate: more than 80 per cent people in rural India do not have access to toilets.

### PARADOX OF A PARADIGM: lack of sanitation spawns outbreaks; access to flush toilets invites ecological catastrophe



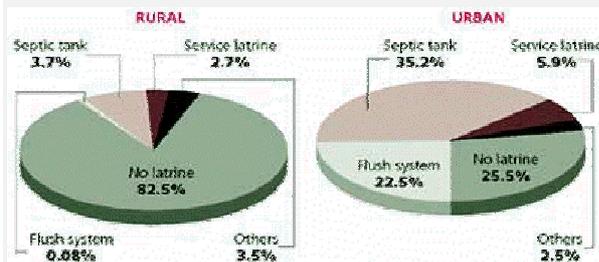
Sources: Peter H Gleick, The World's Water, 2000-2001, p11; Abstract Volume, First International Conference on Ecological

Sanitation, November 5-8, 2001, p7;`Status of water supply and waste

### Human waste is nutrient rich

City	Wastewater	Concentration		
		Nitrogen 30 ml/l	Phosphat 7.5 mg/l	Potassium 25 mg/l
Mumbai	2,456.0	73.7	18.4	61.4
Kolkata	1,432.2	43.0	10.7	35.8
Delhi	1,270.0	38.1	9.5	31.8
Pune	432.0	13.0	3.2	3.5
Hyderabad	373.3	11.2	2.8	9.3
Chennai	276.0	8.3	2.1	6.9

### The urban-rural divide



Sources:water generation, collection, treatment and disposal in metrocities (1994-95), CPCB, August 1997, p32-33; Anon July 1999, Drinking water, sanitation and hygiene in India, NSSO, p40

"Sanitation is more important than independence," Mahatma Gandhi once said. It is been 55 years since independence and sanitation is still a neglected sector in India. Sanitation is available to 48 per cent of urban and just 3.15 per cent of the rural population. As the Planning Commission pointed out in the Ninth Plan, "While the provision of drinking water to urban areas in the country has improved over the years, the provision of sewerage and drainage facilities has not received adequate attention."

### Health costs

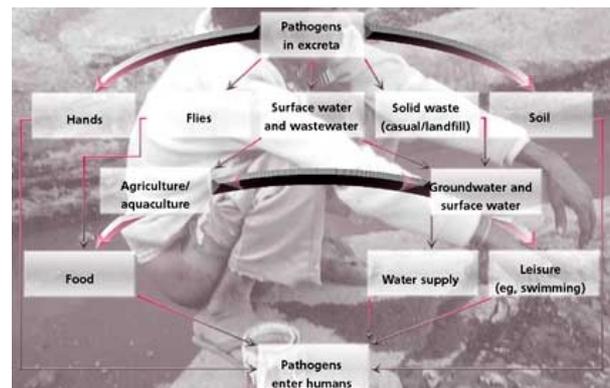
Providing water and sanitation facilities may seem expensive, but the costs of not providing are much higher. In Karachi, Pakistan, for example, a study found that poor people living in areas without any sanitation or hygiene education spent six times more on medical care than people who lived in areas with access to sanitation and

who had a basic knowledge of household hygiene. In India, rural people spend at least Rs 100 each year for the treatment of water/sanitation-related diseases. According to the government of India, this adds up to Rs 6,700 crore annually, which is just Rs 52 crore less than the annual budget of the Union health ministry's and more than the allocation for education.

It is not as if these diseases appear out of nowhere. People contaminate the environment and they are in turn infected through the "pathogen cycle" (see flow chart: Deadly web). Breaking this cycle is the function of sanitation. In simplest terms, sanitation acts as a barrier between humans and disease causing agents. The barriers are generally physical, chemical or spatial. The flush toilets and sewage systems are supposed to provide all three: flushing physically carries pathogen-bearing faeces away from contact with us, the sewage system creates some space between the two, while chemical and other processes in treatment plants are used to destroy them.

### Deadly web

How pathogens in excreta enter humans



Standard toilets and sewage systems are taken for granted in middle and upper class homes in urban India. The attitude is: flush and forget — out of sight and out of mind. However, what happens to the waste after the flush is pulled? After some treatment, it flows in our taps. Possibly, for middle and upper classes living urban environments with

artificially low water charges, there is nothing wrong with it, especially in the short term. But when the whole picture is taken into account, the benign nature of sewage changes dramatically.

Urban sewage systems can be seen as a linear process. The act of flushing lets large amounts of water physically push excreta and diluted urine down and around the "s" seal of the toilet. Blackwater (wastewater which bears human excreta) and grey (wastewater from the bath, kitchens and sinks) are mixed when they leave a house. The pipe carrying this wastewater joins pipes of other houses or apartment blocks and empties into the municipal sewer. This relatively small diameter sewer joins other peripheral sewers and finally joins a large trunk sewage drain. More water is added to stop blocking of sewage lines. Water to transport is pumped and kept flowing. (But not too much water, since this would overwhelm the system.) These sewers keep the wastes flowing to a sewage treatment plant. This treatment involves removing the solids as sludge, getting rid of organic and inorganic pollutants, disinfecting it of pathogens and finally in some state of cleanliness, the treated water is released into the nearest river or sea. The solid sludge left is used either as landfill or as fertiliser. So far so good. At least on paper.

### **Overwhelmed by sewage**

In reality things don't work so well. Firstly, only a small percentage of Indian towns and cities actually have sewage treatment plants. The Central Pollution Control Board points out that out of 22,900 million litres a day (MLD) generated as wastewater, only 5,900 MLD is treated — less than 3 per cent.

So where does the rest (untreated) with its load of dangerous pathogens go? Often untreated sewage is dumped straight into rivers or other surface bodies. The environmental and health costs are enormous: our rivers and our children are

dying. This is because large amounts of water are being taken away from the rivers and used to carry excreta. The 'diluted' excreta is drained into rivers. Most Indian cities are based on river basins and use these rivers as sources for drinking water and waste disposal.

Sewage treatment is also expensive. The Mumbai-based Indira Gandhi Institute of Development Research (IGIDR) has estimated that to provide wastewater treatment in 10 large cities (population of 1.5 million and above) it would cost Rs 1,400-1,600 crore depending on the technology used for sewage management. The land requirement in these 10 cities would be 1,137 hectares. This estimate does not include the infrastructure, which needs to be in place as well as ongoing operating costs. Another assessment by the cpcb says that treating sewage for 23 metro cities would cost Rs 2,750 crore at 1994 prices.

### **No access**

What is even more worrying is that a minority of Indians, who have access to sewers, cause water pollution. According to National Sample Survey Organisation's 54th round survey, 74 per cent of urban population use toilets, but only 22.5 per cent are connected to sewers and 35.2 per cent use septic tanks.

In Indian cities a large part of the population lives in slums and peri-urban area and these settlements quite often have no "legitimacy" and are not factored in any urban sewerage planning. Yet in a city like Mumbai, half of its nearly 12 million residents are either slum dwellers or homeless. They occupy six per cent of the city's land, living in cramped squatter areas with little or no access to sewage and sanitation facilities. When they are included, often under pressure from NGOs, the first thought is to build flush systems and sewerage, which proves to be economically unsuitable. In a slum, up to 500 people could share one toilet. Moreover, very

little thought is given to their upkeep. For example, in Delhi the mcd is the implementing agency for low cost sanitation schemes including community toilet complexes. But these don't work most of the time.

## Scavenging

The drive to do away with scavenging system — the practice in which toilets not connected to sewers are manually emptied and cleaned — was an opportunity to bring in fresh thinking into toilet designs keeping in mind Indian context. But this never happened. Rather, the government stuck to the flush type latrines. With the passing of the 1993 Employment of Manual Scavengers and Construction of Dry Latrines (Prohibition) Act, the conversion of the so-called dry latrines to water seal pour flush latrines got underway. Up to March 2000, Rs 1,339.98 crore had been spent on this scheme, states an appraisal report of the planning commission. Yet, less than eight per cent of the total recorded dry latrines were converted to sanitary ones till the first three years of the Ninth Plan. To meet this huge target of adopting water-intensive technology, the government has to dole out the required money. Funds will be required to not only set up infrastructure needed, but to maintain them, given the growing demand for flush toilets.

Then money will be needed to build sewage treatment facilities. Though industrial pollution in rivers often gets prominence, human sewage is the biggest threat: 80 per cent of pollution in Indian rivers is due to human sewage, says the Planning Commission. The Union ministry of environment and forests (MEF), in its Ninth Plan, fixed a target to set up sewage treatment facilities for 1,591 towns having a population over 20,000, in coordination with Union ministry of urban development and state governments. The question is where will the money come from?

The sewers in Delhi have lost 80 per cent of their carrying capacity due to age and poor maintenance. This means that only 20 per cent of domestic wastewater is being treated, the rest flows directly into the Yamuna. In the case of major river pollution abatement activity like the Ganga Action Plan, only 13.7 per cent of the targeted sewage treatment capacity has been created.

## Constipated mindset

Already, the costs of treatment are not being met. An indication of this is the price of water. If all the water treatment were taken into account in a city like Delhi, the price of water would be Rs 4.61 per litre. Instead, the Delhi Jal Board is charging just Rs 1.99. Revenue generation is 43 per cent of production costs in Delhi. In Kolkata, it's at a ridiculous 14 per cent, in Nagpur, 48 per cent and for Pune, it is 49 per cent. This is just the cost of treating water to make it fit to drink; none of these figures are inclusive of the cost of treating sewage, before putting it into the rivers.

Another important constraint to service peri-urban areas is that lower-cost technologies usually require a much higher level of user involvement than conventional technology to function properly. Yet engineers, who traditionally play a major role in the formulation of sanitation projects, often have little training or regard for the social mechanics of projects, such as mobilising communities and involving future users, and have little patience for the sheer time it takes to address them.



The Planning Commission points out what it calls the "vicious circle of circumstances" — due to economic non-viability of the urban sewage and sanitation, programmes have

failed to cover all the population and due to insufficient funding, operation and maintenance have failed miserably. There has to be a paradigm shift in the way sanitation policies are formulated. The new approach would have to suit the social and geographical factors of the region and be environmentally and economically sustainable. But who will bell the cat

### **Sanitised for not, the writing is on the wall**

#### **NEW AGE APPROACH**

We need to go back to the drawing board to reinvent a green toilet. If necessary, to go back to our past and find technological innovations that are sustainable and equitable. So that every Indian can have access to sanitation and still have clean water to drink. The alternatives to the flush toilets are emerging. These are beginnings of the new approach of sanitation — sewerless and less water intensive

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it is time to go back to basics and examine what toilets and sewerage systems are supposed to do. The point of all these systems is the safe disposal of human waste matter. Flush toilets and sewerage transfer the problem elsewhere; they are complicated ways of spreading pathogens away from the user to the public at large. Toilets and sewerage can be split up into two, since there really is no logical connection between the two, just a historical one. The safe disposal of

wastes can be undertaken in two ways:

Off-plot systems in which excreta are collected from houses and then transported away. This is what the modern sewerage system is. On-plot systems in which safe disposal of excreta takes place on or near the household.

If sewerage and flush toilets are considered indispensable, the way to reduce their environmental and financial impact is controlling how much water they waste. What options are available to reduce water use in sewage systems?

#### **Back to nature**

In the flush system, the water is used not just to clean the toilet bowl, but also to transport the excreta. A family of five who uses a water toilet contaminates more than 150 thousand litres of water to transport 250 litres of excrement in one year. We must recognise that:

- Water is a precious resource and should not be used to transport faeces.
- Waste should be managed as close as possible to its source.
- Faeces and urine are resources rather than waste products.

The first step is seeing our biological "waste" as resources. All organisms need nutrients to grow; plants get these nutrients from the soil. Sewage systems bypass the natural flow of nutrients back to the soil and instead dump these nutrients into water. On an average, a healthy person discharges 100 to 400 grammes of faecal matter and 1-1.31 kilogramme of urine per day, which has nitrogen, phosphate and potassium.

So with this first step, toilets can be seen as collection devices rather than methods of getting rid of wastes. The problem is cultural — a society is "civilised" if it has access to flush toilets; faeces and urine are used only by less developed ones. But if these cultural

blinkers are thrown away, progress can be made towards solving the problem of polluted rivers and groundwater, waterborne diseases and the enormous cost of sewage treatment.

The second step is recognise that water is a precious resource and should not be used to transport faeces. And since we know excreta contains dangerous pathogens, it makes very little sense to dilute pathogens in water. Even if a small amount of pathogen-carrying material is mixed with a lot of pure water, the result is still a dangerous mixture. Unless treated properly, human waste is hazardous waste and "civilised" society puts it into drinking water sources.

The third basic principle is that waste should be managed as close as possible to its source. Ignoring this principle is one of the reasons centralised sewage systems are so unsustainable both financially and environmentally.

### **Sewerage tactics**

One way to do this would be change sewerage tactics. The condominal sewerage system was developed in Brazil as a low-cost option as they cost about 50-80 per cent less than standard systems. Households are connected to small-bore pipes rather than directly to sewers. These smaller pipes meet up and connect to the main municipal sewer. Smaller bore pipes need less water and at far lower pressure, making an immediate savings in the volume of water used to carry faeces.

Another possibility is decentralised effluent treatment. A block of houses or a housing colony can have its own sewage treatment plant. Again this means that compared to centralised systems, far less water is used, as wastes do not have to be transported very far. Treatment plants can be smaller in size since the volume of wastes they will deal with will be comparatively small. Any sludge produced is used locally as fertiliser.

A high-tech system is to do away with water-

based sewerage and have vacuum-based sewer system like the one developed in Germany. If these can be coupled with vacuum toilets there is virtually no need of water. The outflows from toilets, kitchens, and baths are sucked by a local pump into a household vacuum station, from where they are sucked into a central treatment point. Vacuum sewer network can work up to a 4 km radius with one vacuum station. The collected sludge can then be conventionally treated or used in a biogas digester. However, these systems as yet are expensive and energy intensive.

A place where this is being tried is a pilot housing project in Lübeck-Flintenbreite in Germany where an integrated system with vacuum toilets, vacuum sewers and a biogas plant for blackwater as well as greywater treatment in reed-bed filters is under construction.

### **Flush facelift**

Instead of focussing on the sewerage and treatment plants, flush toilets themselves can be modified to the amount of water they use. Low flush toilets that use just one litre per flush have been designed. Quite a large amount of water can be saved and recognising this, many cities, like Los Angeles, usa, are giving rebates to people willing to change their toilets to low water systems, and in some cases, provide them free.

These possibilities make a large difference to the problem of water pollution. But again they presuppose sewerage lines, however small. On-plot sanitation solves this problem.

Toilets originally designed for ships and airplanes are now being adapted for houses. The vacuum toilets mentioned earlier also reduce the amount of water. Electric incinerator toilets fall into this category where the faeces and urine mixture is dried by electric fans and then burnt.

Of low-tech versions the standard on-plot solution seems to be pit latrines. These are merely holes dug into the ground and covered with superstructure that contains the toilet seat or pan. When the pit is full, it is either emptied or another pit dug and the superstructure moved to it. The old site with a topping of soil is suitable for growing trees. Instead of a straight drop, an "s" bend is attached just below the toilet pan, a water seal can be included which cuts off most of the odours. This is basically a simplified version of the septic tank. In terms of the environmental impact, both pit and septic tank toilets pose risks to groundwater. The US Environment Protection Agency has also expressed concern about the amount of groundwater contamination that is caused by septic tanks: they pose the greatest risk to groundwater in the US.

In the desperate race for environmental sanitation, more radical designs are emerging which take ecological thinking to its logical conclusion. Why not then just get rid of the water? This is "ecological sanitation" or ecosan for short, works on the principle Don't mix faeces, urine and water. One need not look towards other countries for successful ecosan design. In India, people in Ladakh have been using such toilets for centuries (see box: Return to nature). Modern versions of ecosan have also been tried and tested in India too (see box: Thinking clean).

### Thinking clean

Ecosan toilets experiments in Kerala

Paul Calvert

Paul Calvert, a Kerala-based ecological sanitation expert, has proved that ecosan approach can work in areas where water is scarce. In 1995, he built his first such ecosan toilet in a coastal village of Kerala. At that time, 80 per cent households of the village had no latrines. Moreover, at least 50 per cent of families were consuming water that

was contaminated due to open-air defecation. However, the main impetus for Calvert was to provide women with some privacy.

Since the water table of the area was quite high and prone to tidal flooding, building pit latrines was not considered feasible. Moreover, building a sewerage system was out of the question. Therefore, the best option was to build ecosan toilets.

Calvert's ecosan toilet consists of a slab built over two vaults. The slab has a hole over each vault for the faeces to drop in and a funnel-like device to collect the urine. Between the two holes is a small drain over which anal cleaning takes place. The anal cleaning water and the urine is together drained into a plant bed.

Paul's design: the compost is removed from the hole, while the urine is used to grow fruit trees

After each use, a small amount of ash is sprinkled down the faeces hole to facilitate the drying process. The two holes are used on a rotational basis for six-months. Before use, each hole is covered with straw to facilitate decomposition. After six months, the decomposed faeces is used as a soil conditioner.

Though these ecosan toilets are as economical as any other sanitation system, Calvert declines to comment on the cost. "Many people judge things by the cost of the hardware. I want to promote the approach, not the hardware cost," he says. He has built ecosan toilets in other countries as well. His system can be used in high water table areas; dry, water scarce areas; rocky sites and flood plains.

### The nutrient loop

Urine is nearly sterile. Faeces, which is 10 times smaller in volume than urine, contain most of the pathogens. If the two are kept separate, urine can be directly used as

fertiliser while faeces can be sanitised and used as soil conditioner. This is why ecosan is described as "closing the loop". We eat plants that get nutrients from the soil. We urinate and defecate and return the nutrients back to the soil.

### **The German-designed vacuum toilet**

Ecosan works by separating the urine and faeces at source and putting both the urine and faeces back into the local nutrient cycle. Designing a toilet pan where the urine and faeces go in different directions ensures this. The faeces drop straight down in a small storage chamber made of concrete or other impervious material. The urine goes to a tank. The faeces is stored and allowed to decompose by a process of aerobic digestion. Ash or other organic absorbing material like sawdust is used to cover the faeces to aid in the drying out process. Time allows heat, given off by decomposition, and normal soil bacteria to kill all the disease carrying organisms. Within six months, the faeces is reduced to humus.

The process used to sanitise faeces can be simply split up into two types; with urine it is a composting, without; a dehydrating process. In both, the action of time and soil microbes destroys pathogens.

### **On the block**

Modern ecosan toilets are already in use where laying sewage lines is a problem. In Sweden composting toilets were first introduced more than 50 years ago. Though a wide variety of models are being used, the 'Clivus' Multrum model is one of the most popular ones (See diagram: the Clivus Multrum composting toilet).

## **THE CLIVUS MULTRUM COMPOSTING TOILET**

The Clivus Multrum is a single vault-composting toilet where urine, faeces and

organic household wastes are combined and processed together. The model is available as a unit and consists of three main components: a composting vault with a slanting floor; air conduits; and a storage space at the lower end. Besides these, a tube connecting the toilet seat riser with the receptacle and a sloping channel for the kitchen waste.

Faeces, urine and toilet paper along with all kinds of kitchen and organic household wastes go into the multrum. The contents slide down slowly along the multrum sloping floor with the fresh deposits at the upper end down to the storage part of the vault. The heap decomposes, reducing to less than 10 per cent of its original volume and gradually forms humus. The humus produced has similar bacterial count as that of soil and is directly used as a fertiliser and soil conditioner. The humus produced in this process is only taken out after five years for the first time and later once a year. In Sweden, this model is used in houses, weekend houses, institutions and as public toilets. One problem is that since there is no diversion of urine the slanting floor poses a risk of liquid accumulation at the lower end of the composting vault. To stop this a container for liquid storage below the composting vault has been provided in a newer version.

Urine separating toilets can be designed for multi-dwelling environment too. Gebers Housing Project is a cooperative housing project — a two-storied building with 32 flats — located in a suburb south of Stockholm. This project involves community participation and was started in 1998 with the primary aim of recycling all nutrients of the human waste to agriculture.

### **The poor cannot afford sanitation systems but pay for the cost of flush toilets**

The urine is flushed with a small amount of water and is carried by gravity to large tanks

under the building from where it is transported to a farm and stored in large reservoirs. There is a natural rise to a high pH of urine and it is considered to be disinfected after six months of storage. Faeces on the other hand are handled dry and fall straight down into individual bins under the house. The faeces is taken out after one year and composted collectively for later use in agriculture.

There are working examples in less developed countries too. China has a large ongoing ecosan programme. In the Guangxi Zhuang Autonomous region in southeast China, Yongning county has 1440 ecosan toilets in 45 villages. In the same region, another county, Beiliu, has 3,316 dry toilets. Most of these are in houses but some are in public use like schools. The faeces are dried in the toilets themselves and are collected and used in three ways. They are put into a biogas digester and the gas made is used provide lighting and cooking facilities for the village. The leftover sludge is applied to fields as a soil conditioner along with the urine. Faecal sludge is also used for aquaculture. The circle is complete.

## **CHASING A DREAM**

It is the poor who cannot afford sanitation systems and are paying the cost of flush toilets and sewerage. We pump our disease-laden effluents towards them. The medical interventions possible for the rich may be out of the reach of most poor people. Most deaths from waterborne diseases are not caused not by the pathogens themselves, but because of dehydration, the victims do not have enough clean water to drink. Malnutrition is also exacerbated by lack of clean drinking water. Flush toilets hijack natural resource like water that the poor depend to meet their daily needs.

Whether donor agencies or government subsidy, there is a lot of money to be made in sanitation and those in power will not easily

give up that power. So governments will continue to build flush toilets and keep chasing the impossible dream of sewerage. Sanitation engineers have no interest in changing the technology paradigm. Water pollution is not their problem in any case.

## **Flush with funds: building public toilets in Delhi**

There is no need to import expensive technological fixes. Ecological sanitation shows that there are new approaches, and that these are based on traditional understanding of the human- environment relationship. These are not really new technologies just a new way of looking at things. Alternatives to the flush toilets and sewerage are needed and an understanding of basic environmental cycles shows us the possibilities. Put back what you take out.

But most important need is a change in mindset. The flush and forget attitude is not working. The faster we realise this, the better.

*With inputs from Priyanka Chandola*

