WHAT WOULD MAKE ECOSAN A PRIVILEGED SOLUTION?

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Introduction

More than a century ago proponents of flush toilets in Sweden struggled hard to become accepted, and for the last several decades this toilet has been the norm against which alternatives are assessed. In this historical process of change, it may appear strange that engineers often used health arguments for the WC, while medical doctors seem to be absent in the discussion. Few economists paid attention to the WC-solution, and it appears that the flush toilet arrangement has been above dispute for a long period. In effect, this technology has attained the position of a privileged solution to sanitary problems.

In this paper I will try to establish what it may take for EcoSan arrangements to become a privileged solution. The presentation departs from Swedish historic experiences.

The evolution of piped systems in Sweden

The first Swedish National Health Act of 1874 dealt only with dry sanitation systems, while the second Act of 1919 only discussed piped toilet systems (Drangert, Nelson, and Nilsson 2002). The household coverage of piped water and sewer in urban areas developed as seen in the figure below.

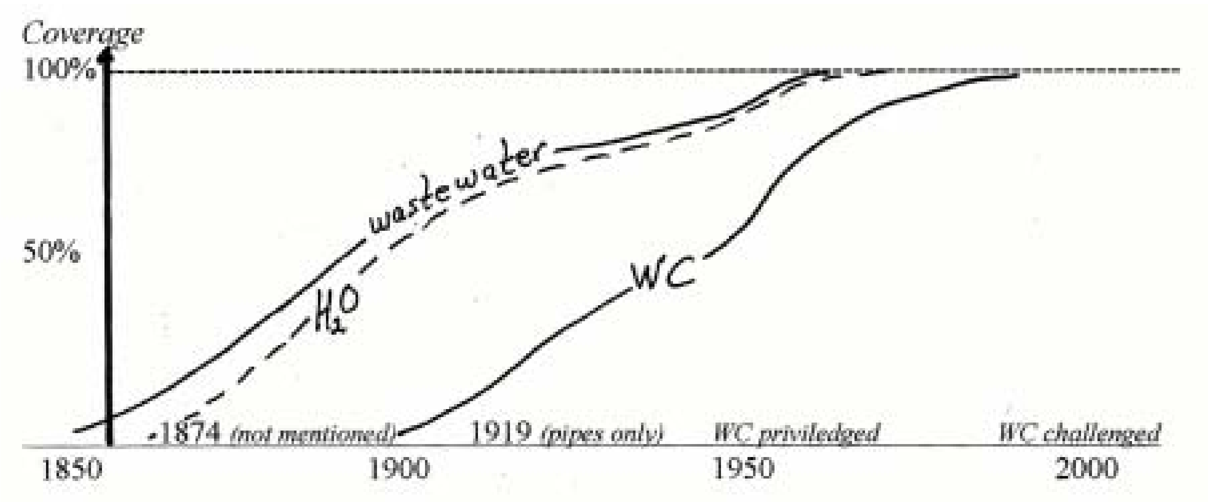

Figure 1. *The evolution of piped water and wastewater in Swedish towns*

Two major conclusions from the diagram are that (i) it took a long period to attain full coverage and (ii) there was a slow, stepwise improvement of the system.

The EcoSan technology that is available today has a long history. For example, the toilet on the picture was introduced in Sweden in the 1860s when several-storey buildings became popular. This urine-diverting toilet solved the problem residents had when descending 4-5 *floors to visit a dry toilet in the yard, and then return 5 floors – with no elevator. This no-flush toilet with a vent pipe was odourless and installed in the flat. It was introduced in a period when the sewers from flats were of too small dimension to accommodate faecal material. The faecal matter was collected, say, every three month, and brought back to farmland. However, the nutrient-rich urine in the porcelain bowl was emptied in the kitchen sink and discharged in rivers and lakes – and not recycled (Drangert and Hallström 2001).*

***Figure 2**. Urine-diverting toilet from 1863 with urine funnel and collector (broken) in porcelain, and faecal container of metal sheet. (Photo Drangert 2001)*

The water and sanitation management in small towns developed from infiltration of used water to the groundwater or discharge to rivers and universal reuse of excreta to an outspoken ***supply and discharge management.*** The water supply management remained unquestioned up to the 1980s. At that time, it became evident that it is cheaper to hold back consumption by ***demand management*** than to construct new water schemes. We now discern a return to an era of ***reuse management*** using tariffs and saving devices. This time the goal is sustainability, and it includes stewardship by all, especially concerning the prevention of serious pollution of used water.

The flush toilet under stress for not being environmentally sustainable
The flush toilet technology was under environment-induced stress in its infancy. Early

city regulations stated that the WC must be connected to a cesspool before emptied into the sewer mains, since the council did not want to have all the excreta emptied into lakes without any treatment. Such cesspools were constructed in cellars of houses or dug into courtyards. A major problem at the time was bad smell from and overflow of cesspools, and eventually the council allowed a straight connection between the WC and the sewer line. The ensuing deterioration of water bodies caused public concern. The countermeasure was to move the outlet of sewers further and further away from the town as years went by.

In the 1950s treatment plants were built to treat wastewater before disposal into nature. The environmental situation improved and at least part of the treated sludge was returned to farm land as fertiliser. However, as more and more chemicals were being introduced in consumer products and industry, the quality of the sludge deteriorated. In the 1990s the farmers´ union in Sweden decided to recommend their members not to use sludge because of the long-term accumulation of heavy metals in the soil.

The WC-system is now under some stress, since it does not fulfil the requirements of environmental sustainability. Sector professionals and researchers try hard to develop and improve the operation of existing systems and many new technical improvements are being introduced.

Search for ecological alternatives on a global scale

Another factor that puts the privileged flush toilet under increasing pressure is the rapid urbanisation in most parts of the world. It is well known that a technical arrangement tends to carry with it a management set-up, and the flush toilet system is no exception. It is installed and operated by professionals. The high investment cost for sewers and treatment plants and the rigorous requirement of a functioning management put city councils under severe stress. Also, the large number of newly arrived, un-served residents may not have a strong influence on town council priorities, but their share numbers and the health risks they represent to society seems to be enough to worry decision-makers. If councils fail to deliver conventional water and sanitation services, local solutions emerge with alternative technical and management arrangements that may work as well as the flush toilet. In some un-served societies the nutrients from human excreta is recovered and reused for food production.

The increase in world population and, more importantly, rapid urbanisation forces upon us a new perception of disposal of human waste in the future. A simple interpretation of the global population statistics (Figure 3a) shows that the number of man-years in the present century equals those of the previous four centuries (shaded areas equal in size). Thus, the global population produced the same amount of human excreta in the 20th century as in the previous four. However, there is a difference between the two periods in that most of the excreta was returned to agriculture before 1900. If we generally say that excreta from urban settlements is not returned to farms (although we are aware that, in many countries, farmers collected night soil from urban areas) then we find an even more striking feature of the present century. The excreta from the urban population will equal the excreta from all previous generations (Fig. 3b, using the lowest UN estimate of the population increase).

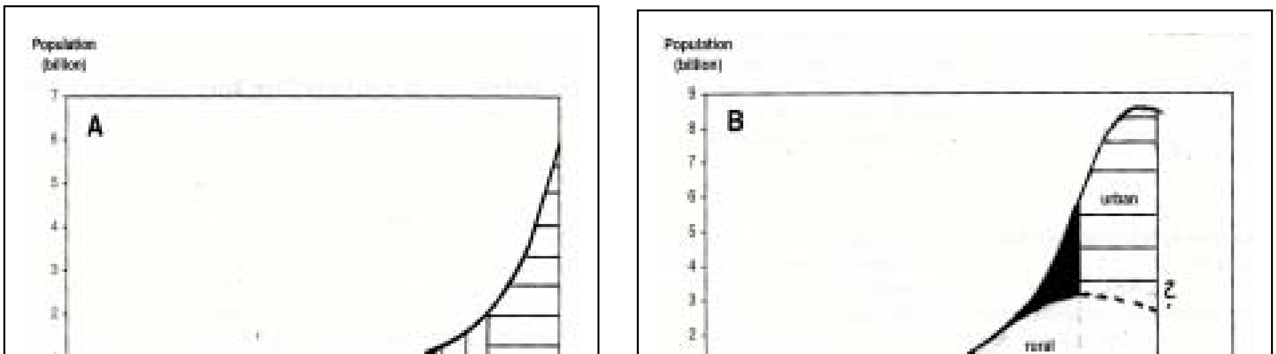

Figure 3 *World population figures.* ***a:*** *World population from 1500 to the year 2000.* ***b:*** *World population in urban and rural areas from 1900 up to the year 2050 according to the low alternative of UN (World Population Prospect, 1996 and Urbanization Prospect 1996) and authors´s extrapolation to the year 2100*

The human body utilises the energy in the eaten food, while the rest of the food is discharged as excreta. The content of nutrient in excreta should therefore be about enough to fertilise the next crop. Human beings need to eat food corresponding to some 250 kg of cereals annually to fulfil the body´s requirements. The nutrient content in urine alone amounts to 71 to 88 per cent of the requirement for the corresponding biomass production. The so-called urine equation tells what land area is needed for this production and to what extent the nutrients in a person´s urine will cover the need for fertiliser (Drangert 1998):

The Urine Equation:

> *An (1) adult eats 250 kg of cereals per year, which has been grown on less than 250 m^2 and fertilised to perhaps fifty per cent by the person´s urine, mixed with her used wastewater.*

The key ecological question is if we can continue to deprive farmland of nutrients by transferring them to the cities as food and disposing the ”used” nutrients in water bodies and dug pits. The seriousness of this concern is manifested by the eutrophication of lakes and seas and pollution of water courses. Also, the food production to feed the population will require at least a 3-fold increase in fertiliser input in the 21st century. However, accessible phosphorus and potassium deposits in the world are estimated to be depleted within a century or two. Alternative sources of fertilisers may appear, however, one of which is to reuse nutrients contained in human excreta.

Requirements on a user-friendly and sustainable sanitation system

There are many kinds of requirements on a sanitation system in order to be more sustainable and user-friendly. One aspect is the reuse of nutrients. The urine equation above shows that an important step towards a sustainable society is to return urine to food production.

Another set of requirements deals with unnecessary pollution of wastewater. We know, for example, that it is very convenient to use the toilet as a waste collector. Residents do not experience the damages caused by throwing alien items into the toilet such as paint residues, medicines, diapers, solvents, etc. They may think that the wastewater treatment plant is capable of cleaning everything. To curb such practices, the sanitation arrangement has to be transparent enough to inform residents about what practices are abusing the system. This may be the weakest point of the flush system *since it is non-transparent. At the same time, it may be a welcome challenge for engineers and natural scientists to find treatments for all new chemicals on the market.*

Most policy documents from international organisations pay tribute to “management at the lowest appropriate levels”. The WC is, almost by definition, managed at city level, especially if the wastewater is not just discharged untreated in a water body. In contrast, in small-scale systems the household is the guardian of environmental sanitation and discharge of used water. By keeping the soil surface free from polluting objects and activities, the quality of groundwater in periurban areas is safeguarded. The management of a WC or an indoor urine-diverting toilet is easy and the latter leaves no foul water in the groundwater. Thus, this water source can continue to be used directly by households.

Some of the positive features of the WC include that it is easy to clean, is odourless, is indoors, and benefits health. These are features that earlier pit latrines and dry toilets did not have, and therefore made them substandard in comparison with the flush toilet. In the following we will try to compare the WC with the *modern* urine-diverting toilet which is a technical development of the simple version from the 1860s. In Table 1 a number of important requirements are listed, associated with users, society and nature. The degree of fulfilment by the WC and urine-diverting systems is assessed.

Table 1. *Fulfilment of various user and sustainability requirements on toilet systems*

Requirements:	***WC***	***Urine-diversion***
- no smell, no flies, no maggots	OK	OK if well managed
- indoor for control and security	OK	OK
- easy and safe to clean and maintain	OK	OK if properly built
- hygienic handling of urine & faeces	OK as long as utility operates properly	OK but unpleasant
- affordable to residents	rarely	there is an alternative for every pocket
- no degradation of the environment	leakage to ground-water and overflow, eutrofication if there is no treatment plant	OK
- resource saving	wasteful use of water	OK
- reuse of nutrients	accumulation of heavy metals	OK
- flexibility	no	OK can be improved, moved to new place

Urine-diverting toilets are odourless and therefore possible to install indoors. Thereby the household can control its use and keep it as clean as they want. The benefits will occur only where the toilet is inside the house or flat. The urine-diverting toilet would change few practices, however. The frequency of hand-washing after defecation will increase substantially if indoors, thanks to easy access to water and soap. It turns out that a urine-diverting toilet has the same positive features as the WC when it comes to convenience and hygienic safety indoors.

Today´s urine-diverting toilet also provides various possibilities to recover and reuse the nutrients in human waste. Due to its transparency, users will not throw alien objects into the EcoSan toilet. They know that the content will be used for their own food production or in the vicinity. The urine-diverting toilet encourages, in contrast to the WC, good user behaviour and thus guarantees a high quality fertiliser, ready for reuse in the nutrient cycle (Stockholm Water Company 2001).

The urine may be collected outside the house in a plastic vessel or urine tank. The system may be installed at a single household or connected to several neighbouring houses. If the urine is stored for half a year, all pathogens have died off and the urine is safe to use in the garden. In case a single household uses its collected urine, they can apply it safely on a number of crops after a shorter storage time (Schonning 2001).

Few societies have cultural objections to handling and reusing urine (Drangert 1998). The case for faecal material is different, and many societies are faeco-fobic with important exception such as China, Vietnam, and Japan (Drangert et al 1997). In the case of urine-diverting toilets the amount of dry faeces is small, since they constitute only ten per cent of the total volume of human excreta. The chamber or bucket for faeces needs to be emptied only rarely. The inconvenience is also reduced by the fact that also faecal material is hygienised and inoffensive by storage for half a year. The resulting soil can be used as soil conditioner or simply be burnt.

A privileged future?

The option to ”sewer the world” is rapidly fading away in the light of global urban population increase, limited funds, difficulties in treating wastewater due to the explosive increase in the use of chemicals by man, etc. Therefore, it seems unavoidable to make the environmentally wasteful sanitation installations during the 20th century a parenthesis in human history.

The urine-diverting toilet has several features that may outplay the WC when it comes to transparency, robustness of operation, affordability, reuse of nutrients in food production, and that it does not pollute the groundwater in the way dug latrines and leaking sewers tend to do. Another favourable feature is that the household investment in a urine-diverting toilet is a long-lasting one, since the toilet can be brought along when moving to a new place. The prospect of urine-diverting toilets becoming a privileged sanitation solution is promising, for the benefit of man and nature.

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