

Ecosan – The Big Picture

Steven A. Esrey
UNICEF, New York, NY

Transcript from the keynote presentation at the first International Conference on Ecological Sanitation, held in Nanning, China, from 5-8 November 2001.

To understand the overall picture of ecological sanitation there is a need to put it in a proper context. Toilets, particularly ecological toilets, are a major part of the Ecosan concept, but are only a part. Ecosan encompasses more, it's about a way of life, and how we should live on this planet, not just about how toilets should be different. I hope that by the end of this presentation you will see the difference.

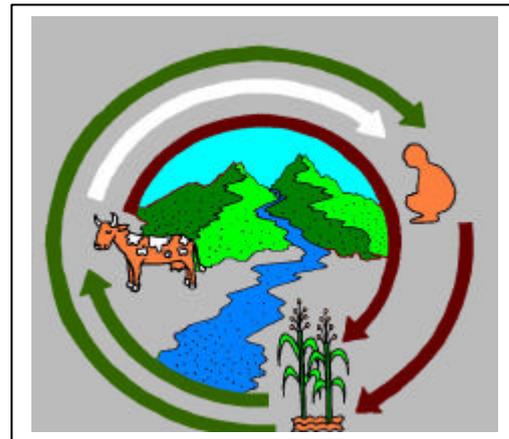
Imagine you are on a space mission, to a distant planet like Mars. It would take at least six months to travel there, so you could only take a limited amount of food and water, as well as air. What would you do? How would you handle human excreta to maximize your resources, and minimize the extra supplies you need? Over time, NASA, the National Aeronautics and Space Administration, has had to deal with different types of manned space flights. Briefly, over the past 15 to 20 years, NASA has moved from a combined toilet system, to urine diversion with recycling, to finally, utilizing urine diversion with food production. In fact it is more sophisticated and complex than this because of the special needs of space, for example zero gravity, need for low humidity, and the ability of microbes to survive and thrive in spaceships. At first, urine diversion offered some obvious advantages: reduced odors, better hygiene, and easier handling of solid wastes, which could be compressed and dehydrated so the entire toilet didn't have to be removed upon reentry into earth, just the chamber holding the feces. Female and male urine funnels were developed to allow astronauts to stand during urination if they chose to do so. All liquid wastes from urine, perspiration and respiration, showers, hand washing, food preparation, and even laundry were also collected into one stream of liquid waste. Through treatment of various sorts, including microbial processes, reverse osmosis, removal of salts, etc., water could be recycled to be of drinking water quality and used again for showers, hand washing, shaving, etc. Odor was removed through air filters, which also removed excess moisture, which was returned to the waste collection stream. This kept the spaceship at 20 degrees humidity, which would otherwise continue to rise. Low humidity also allowed for easier dehydration of feces, which is normally 50-80% moisture content. Currently, experimentation on food production is being done as well as for the long duration space mission, likely to Mars. About 85% of the liquid waste fraction can be used for growing food. Candidate plants at this time include leafy vegetables such as lettuce, spinach, chard, and perhaps radish, carrots and onions.

We also live in a spaceship, called Planet Earth. Our spaceship may be bigger, it holds a larger crew, and it can carry more resources. But there are some differences such as zero gravity, which lead to different designs, using airflow instead of water for example, to move liquids through space. But there are similarities, which make the analogy to space relevant. We need to preserve and protect our resources, particularly fresh water and soil

fertility for future crews, that is, our future generations. We need to prevent disease, and promote and safeguard health, not just treat disease once it occurs. Today we have more than 6 billion people. Soon we will be 50% urbanized, living within 50km of a coastal system. We are pushing natural resource limits, and worrying about pollution limiting our use of other resources. The problems we have today cannot be solved with the same kind of thinking that created them. Business as usual approaches to excreta disposal management are either failing to provide any service, or providing conventional services, representing a failure in the design of excreta disposal. A new approach is needed.

Ecosan – an ecosystem approach to the Management of human waste

Ecosan: what is it, and what does it look like in a picture? Ecosan is a closed-loop ecosystem approach to the management of human excreta. In the simplest sense, if we look at the man, the woman, or the child squatting, we see that the waste is returned to the land, the brown line, for the production of green plants: food, flowers, trees and the like. The green plants are then returned to humans, the green line. In societies that include animal husbandry, just add another layer to the closed loop system. In some parts of the world it may be cows, whereas in other parts



of the world it may be pigs, buffaloes, chickens, etc. There are a couple of points in the diagram above I would like you to notice. First, there are no visible external inputs to this picture. Ecosystems generally have all they need locally, with the exception of the energy from the sun which provides power to the entire ecosystem. Second, there are no external outputs from the system. All wastes are converted by microbes, fungi, etc. to a valuable resource for another life form. If we export waste from the system, we often create toxic pollution elsewhere, often in a different ecosystem, such as pollution in marine environments. Quite simply the Ecosan loop can be summarized as follows: food for people, and people for food.

The 3 basic principles of Ecosan

- **Promotes health and prevents disease**
- **Protects environment & conserves resources**
- **Recovers and recycles nutrients**

Ecosan has three basic principles. First, it promotes health and prevents disease. It does this by treating excreta as near as possible to where people defecate rather than flushing it downstream for the unfortunate to cope with. There are several ways to treat excreta, one of which NASA does, that is dehydration. Second, Ecosan approaches protect the environment while conserving resources. One of the main causes of fresh water pollution is sewage. By not using fresh water to transport excreta, and returning it to the land after

treating it, water is conserved and protected. Finally, Ecosan approaches recover nutrients in excreta, return them to productive uses, and therefore recycle nutrients. Food for people, people for food. This is very important for certain nutrients like phosphorus, which has limited global supplies, is available commercially from only a few countries, and introduces toxic chemicals when used in commercial agriculture.

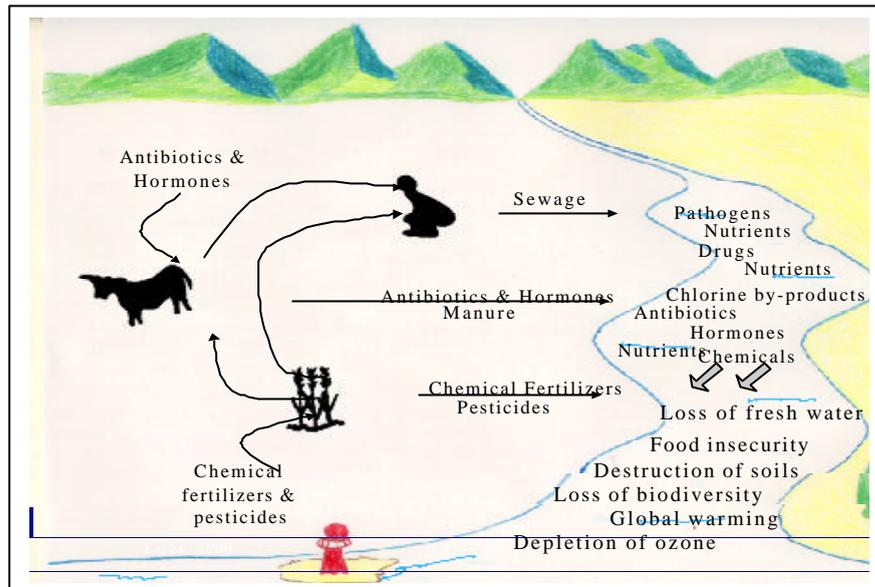
Ecosan – basic assumptions:

- **Excreta are a resource**
- **Water is not a sink or a medium for waste**
- **19th Century assumptions incompatible with sustainable devt.**

Ecosan also has some key assumptions which reflect our new thinking. First, excreta are a valuable resource, not a waste. In nature, there is no such thing as waste. It is a concept invented by humans. All waste is a food for another living organism, therefore we should not argue about where to put our waste, who will pay to dispose of it, and how long we can wait until it leaks into the environment. We need to design systems that mimic healthy ecosystems found in nature. We need to challenge some of the commonly held beliefs. Second, water, a valuable resource, and finite, is not an environmental sink for human excreta. When manmade wastes are put into the wrong sink, for example air pollutants into water, the resulting pollution can cause a myriad of cascading problems. For example, air pollution leads to acid rain, which in turn fells forests, downwind. Three, when Western human excreta solutions were developed 150 years ago, people in the 19th century lived in rural areas. Human excreta solutions were designed and built on the premise that excreta were suitable only for disposal and the environment was capable of assimilating it. The prevailing health view at that time was that bad odors lead to disease. The solution was to get rid of odors, by using water as a transport medium and sink. Excreta were conveyed to rivers, and streams, and oceans, but such linear approaches remain widely prevalent today. The times have changed, the premises are outdated, and the current solutions contribute to a plethora of problems that continue today.

What happens when we open the loop?

When one part of any ecosystem opens, other parts open as well. Let's start again with the squatting person (see figure next page). If excreta are buried in pits or flushed into rivers, lakes, or oceans, the water-receiving bodies wind up with pathogens, nutrients, drugs, hormones, and of course polluted water. Many types of pharmaceutical and personal care products are showing up in drinking water across the globe due to sewage pollution. The pharmaceuticals include lipid-regulating drugs, analgesics, chemotherapy drugs, antibiotics, hormones, antiseptics, beta-blocker drugs, epilepsy controlling drugs, and drugs for contrasts during scans. The fate of these drugs on wildlife is beginning to be understood, resulting in reproductive failure as well as other problems. The impact of all this on humans still remains to be known. Plants need nutrients, which are not put back into land if excreta are disposed of improperly, for example, into water bodies.



Thus, chemical fertilizers are needed to replenish soil. But a depleted soil results, becomes lifeless, creating unhealthy plants that require pesticides. Fertilizers and pesticides also leech into the environment. Hormones and antibiotics from animals suffer the same fate. These problems affect human health in a negative way: diarrhea, infant mortality, low birth weights, malnutrition, as well as cancer and other chronic diseases. Ultimately, these pollutants may lead to loss of fresh water, food insecurity, destruction of soils, and loss of biodiversity on land as well as in marine environments, global warming and depletion of ozone.

Ecosan - a sustainable solution:

- **Challenging concepts and values**
- **Ecological design**
- **Networking and demonstration**

How can we achieve a sustainable solution? First, we need to challenge our concepts, values, and language that we hold very dearly. A lifeless view of the planet makes it easy to say things like “inadequate excreta disposal”, when in fact we are polluting our own Mother, that is, Mother Nature. We should not own, manage, and control nature, rather we should mimic and nurture her processes. We need to move from linear thinking to closed-loop solutions, from pollution control to zero discharge, from cradle-to-grave to cradle-to-cradle technologies. In other words, work towards, and talk our way toward, closed-loop thinking and closed-loop actions. Second, we need to consider ecological design. Ecological design is not solely about a technology, as much as it is about a mindset of a culture. Ecological toilets should follow how we think today about sustainable living, not how 19th century people thought, when sustainable was not even in people’s vocabulary. Let me give you a design assignment, a retroactive design assignment. I would like you to produce a human excreta waste system that produces poisons and toxins, and it uses clean water to transport it to lakes, rivers, and oceans. I want you to create as much as you can, make it smell so it attracts flies, and concentrate it as much as possible by releasing the liquid fraction into receiving bodies of water. If you can’t flush it with water, bury it in pits, the deeper the better, so the contents can leach into water bodies. Preferably, flush it away downstream, to those who are poorer who

won't complain. Now, create thousands of regulations, particularly complex ones, that no one can follow. Erode biodiversity as well, by creating technologies, particularly ones that don't work well, ones that must be evaded. In most of the world, a world full of poverty, poverty of income, poverty of resources and capacity, and poverty of political will, what will be done, if anything, about this design experiment? Unfortunately, this is what we have been doing for the last 150 years, and it reflects a culture and thinking of 150 years ago. Twenty-first century solutions require 21st century thinking. Finally, we need to continue to innovate, adapt to local cultures, and share our experiences through better networking.

Ecosan - factors defining success:

- **Indicators for Ecosan**
- **Changed thinking and approach**
- **Norms for sustainability**

We need new indicators than those used by conventional practitioners. We need environmental indicators, which measure soil fertility and erosion, stream or water quality, ecosystem health, pollution prevention measures. We need economic indicators, that measure energy consumed by Ecosan systems, health and disease rates, as well as health promotion and disease care expenditures and their ratios, in addition to employment generated. We need community indicators that measure local empowerment, self development, and school curriculums that address Ecosan issues. We need to measure how our thinking and approaches change. Do we continue to apply linear thinking and solutions or closed-loop ones? Finally, we need to identify norms for sustainability. These may include, but are not limited to, putting costs on decision-makers. This would favor local ownership, decentralized systems, and easier regulation of environmental protection. We need to honor government's role as a maintainer of public infrastructure, protecting rights of individuals and communities, promoting equity and equality, full disclosure, knowledge sharing, and of course managing borders of ecosystems. At the same time we need to seek diversity, self-reliance, knowledge-sharing, systems that are of human scale, and finally, transparency.