Dry and Separation Toilets
– of Gunter Pauli

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Reflections on the Gunter Pauli article « Dry and Separation Toilets »[1]

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(adapted and translated by André Leguerrier)

Toilets in developing countries

The problem of toilets in developing countries must be addressed differently from those in industrialized countries. In developing countries, outside of urban centres where the problems are the most serious, the biolitter toilet (BLT)[2] is a very inexpensive solution[3], accessible to all. Plus, its management fits in well alongside rural and urban agriculture (i.e. small city gardens) by providing valuable compost. By eliminating the production of sewage in urban and periurban areas, its use contributes effectively to public health and acts as an environmental safeguard, especially if there are no sewers. In these countries, carbon-based litter can include shredded cardboard packaging diverted from landfills, or other cellulosic plant-based material. Given that the BLT is installed within the home, many security issues vanish, especially for women who would otherwise use communal latrines. Placing a commercial source-separating dry toilet in a small home poses a problem, especially for a large family, not to mention its much higher cost than a « do-it-yourself » BLT. In Haiti, Joseph Jenkins' BLT [4] (called a « Humanure Toilet ») works well and is appreciated by the population.

Scandinavian toilets

Source-separating dry toilets were developed and refined in the Nordic countries to meet today's water management needs and paradigms (questionable as they may be). Source-separating toilets are presented as the best solution to manage human waste.

Listening to a Danish specialist, I learned that the idea of separating faeces and urine was based on «the fact that animals don't defecate and urinate in necessarily the same place in nature». In our opinion, separation stems rather from the will to space out the emptying of the dry toilet. Indeed, about 90% of the mass of our excreta is liquid, and thus easy to collect and store in a container. The remaining 10% of solids are much easier to manage, for example by drying.

The basic guiding principles used by the designers of these toilets are as follows:

- The need to protect the user from bacterial and viral contamination,
- The desire to remove human waste from sight and smell,
- The need to use as little water as possible.

[1] Link: http://www.theblueeconomy.org/uploads/7/1/4/9/71490689/case_19_dry_and_separation_toilets%C2%A0.pdf.
[2] Link: http://www.youtube.com/watch?v=zUTaiFItH58
[3] Link: http://www.youtube.com/watch?v=dbo7ZXZozWc
[4] Link: http://www.youtube.com/watch?v=k86rzVGqfEg&feature=youtu.be

Technically, the aim is to create a toilet that is just as convenient as a flush toilet, with little water consumption and no sewage to be treated. Protection of the environment does not seem to be a guiding principle for the toilet's designers. Indeed, saving water is considered an environmentally-friendly act!

The solutions and intricacies put forth to meet these requirements are only interesting from a technical point of view.

The importance given to protection against bacterial and viral contamination reflects the dominant present-day attitude, which has its roots in the 19th century's hygienics concept. For various reasons too long to explain here, we do not share in this view. Many clinical observations have shown that disease can occur even without notable external pathogens, insomuch as the body's diathesis (i.e. the immune system's inherent predisposition) is favourable to the onset of disease. Conversely, when the diathesis is unfavourable to disease, contamination with pathogenic microorganisms may have no effect on one's health.

«Sanitary risks» are a natural phenomenon

One can observe the anthropocentric nature of issues such as «sanitary risks» and hazards from viral or bacterial infection. Man is isolated from his environment because he disregards the fact that he is part of the biosphere, like are other living beings. His ultimate goal is to eliminate and kill bacteria and viruses, because these have been declared man's « Public Enemy N° 1 ». Strange behavior in a world advocating biodiversity. An alternate view we prefer is that microorganisms are an integral part of the living world. Those that may have pathogenic properties are like predators in the wild, just playing their regulatory role. Lest we forget that it is thanks to newly discovered bacteria that we find more and more remediative solutions to oil pollution in soil?

Another observation concerns the fact that human waste is considered a dangerous matter to be eliminated, thereby disregarding its integral role as part of Nature's great cycles. In nature there is no wastage. There are only stages of transformation throughout those natural cycles.

Environmental impacts of source-separating toilets

Technically, as soon as urine and faeces are separated, odours are inevitable. The designers of these toilets solve the problem by integrating various ventilation techniques. Yet dejecta, whether human or animal, cease to emit odours when combined with plant-based cellulosic materials. Here, the presence of urine is essential because it creates the moist environment necessary to biologically inhibit the enzymatic hydrolysis reactions responsible for odours. The combination of the two types of biomass (plant-based and animal-based) stops the deconstruction process and initiates a synthesis of amino acids having a high molecular weight, which will later come to form humus in the soil. Users of the biolitter toilet (BLT)[5] are familiar with the fact that urinating on plant-based litter covering the faeces eliminates odours, as will a spray of water. There is no need to use forced ventilation since the smell does not reappear. When placed in a home, the toilet simply becomes a small piece of furniture.

At the Laggarberg School in Timrå (Sweden), it is said that toilets transform faeces to make « compost ». I also read in their beautiful flyers on source-separating toilets that dried faeces are

[5] Link: http://www.eautarcie.org/images/blt-text-en.pdf

simply called « compost » - which goes against current knowledge about paedogenesis. Also, urine is used to fertilize a golf course, after having been diluted with 10 parts of water.

These assertions call for comment. First, when urine is stored, the ever-present enzyme called urease hydrolyzes urine's main component, urea [or carbamide $(NH_2)_2CO$] to form carbon dioxide CO_2 and ammonia HN_3. In the presence of air, ammonia is oxidized into nitrous oxide ions NO_2- (quite toxic), which in turn are oxidized into nitrate ions NO_3-. Thus is formed a more or less concentrated solution of ammonium nitrate NH_4NO_3, a chemical fertilizer identical to that obtained by chemical synthesis. This explains the « fertilizing power » of diluted urine. Urine behaves in the soil just like a chemical fertilizer, which uses up the carbon content in the humic substances by breaking these down. (The carbon that was present in the urea has already dissipated into CO_2 gas while urine was being stored.) The result is a « burning » of soil's humus, which slowly dies. From then on, the soil can only be productive with the help of chemical fertilization « infusions ».

Now let's examine the other objective, saving water. A man produces about 1.5 liters of urine per day. Adding another 10 parts of water represents a total water consumption of 15 liters, about the same order of magnitude as a low-flush toilet.

Let's also look at the nitrogen balance sheet for this type of toilet. Through his dejecta, a man produces approximately 4 kg of nitrogen. Considering that European standards allow for the application of 200 kg of nitrogen per hectare per year on farmland, one man needs to have a 200 m² parcel of land at his disposal for spreading his dejecta in his garden so as not to exceed those standards. For a family of 4, this means 800 m². If there is insufficient land for the purpose, standards will be exceeded, leading to pollution of ground waters from nitrates. In reality, spreading diluted urine on the ground has exactly the same environmental impact as that of liquid pig manure. Both techniques are destructive and polluting for soil and ground waters.

Here you see that source-separating dry toilets share the same logic as that of chemical agriculture, which considers the mineral soil as a non-living substrate, in which you need only introduce – in whatever form – N-P-K nutrients to obtain a harvest. This disregards soil life that can only exist thanks to the molecular structures that constitute stabilized organic matter. <u>In reality, good «living» topsoil is the starting point of all life on the continents.</u> It is an environment that harbours an extraordinary diversity of living beings that live in symbiosis with plant roots. Chemical fertilizers eliminate this living world and produce diseased plants that nature tries, in turn, to eliminate by mobilizing pests and diseases. Thus emerges the need for pesticides. Their use can only lead to the destruction of the last traces of life in soil.

It is not enough to introduce organic matter into the soil to form humus. A series of conditions need to be met. A prerequisite is combining plant-based biomass – carbon-rich – and animal-based biomass (dejecta) – nitrogen-rich – to form a mixture which is the starting point for the formation of living soil. This mixture, like in nature, must come in contact as soon as possible with the soil and the organisms that live there. Composting of only faeces, in enclosed containers, does not meet these conditions. Windrow composting of dejecta and fermentable organic matter is a somewhat efficient imitation of nature. The most economical and efficient way to form humus for the soil is ground-surface composting[6], a sort of imitation of the processes taking place in forest soils. Dejecta (urine + faeces) are combined with enough plant-based material to adjust the carbon/nitrogen ratio (C/N) to a value of about 60. This mixture is then spread on the ground in a layer of about ten centimetres thick. It is then covered again with cellulose-rich material (straw, culled plants,

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[6] Link: http://www.eautarcie.org/en/05f.html#c

shredded cardboard, leaves, etc..). And let nature take its course. After one year, the spread materials will have been absorbed by the ground, « digested » by the myriads of soil microorganisms, which act quickly. Using this basic method, one obtains a rich, fertile, living soil, even when starting from a completely sterile ground. This approach to regenerating degraded soils is unthinkable today, due to hygienics-based arguments, even though there is no health risk. The systematic prohibition of this approach has serious consequences on a global scale.

A good dry toilet also produces energy

Take note that this discussion is not about biogas production. Considering the poor state of today's farmlands, biogas production is an environmental wastage. In addition, biogas production has a very low efficiency, while also mineralizing (thus destroying) a lot of the organic matter.

The alternative we propose is to recover the heat energy released by a special windrow composting technique called thermogenic composting, to heat homes and greenhouses. This is presently an experimental technique which yet needs to be refined. During composting, part of the organic matter is « burned » (i.e. a biological combustion) to produce energy, but this « combustion », like everything in nature, is highly efficient, generating low temperatures of about 60°C. This temperature is not only sufficient to kill off faecal-contaminated bacteria, but also helps to break down drug residues contained in human waste. By means of a heat exchanger located in the heart of the heap, one can produce hot water for months, at a temperature between 28° and 35°C, which is ideal for underfloor heating. First experiments have shown that to maintain heat production beyond six weeks, one must intervene (adjust the moisture content, supply air) to boost fermentation.

Green Energy's True Performance

It is a well known fact that the energy efficiency of heating decreases strongly with the temperature at which energy is produced. In a boiler, furnace or fireplace where plant-based materials are burned, the temperature is of the order of 1000°C, while the use of energy is at a temperature of 50 to 60° C (in the radiator). The temperature difference between energy production and energy use is large. Any thermodynamics expert knows that this involves significant energy degradation, with heavy losses. In an underfloor heating system using thermogenic composting, energy production is 60° C and energy use is 30° C. The temperature difference between production and use is lower and the yield is much higher. Very little organic matter is « burned » for a given amount of thermal energy actually used. Insofar as one technically controls the management of the fermentation process, recovery of heat from the composting process is likely the most efficient and rational energy recovery technique from biomass. Compared to high-temperature combustion, it takes up very little matter and produces little CO_2 with respect to the unit amount of energy used. But the main advantage is that the final by-product of this energy production technique is not ashes (= potassium fertilizer, destructive of soil), but a highly valuable organic amendment for agriculture.

This is why we forewarn: large-scale combustion of plant biomass for purposes of energy production is an environmental wastage. Our farmlands are definitively dying and disappearing by erosion, due to lack of humus. Under these conditions, burning plant-based materials (= potential humus when combined with dejecta) directly or as biogas, biofuels or pellets is a grievous attack on the biosphere. The value of the energy so-produced is only a small fraction of the biomass destroyed.

These considerations are absent from the source-separating dry toilet discourse.

Source-separating toilets in an ECOSAN perspective

When one abandons today's paradigms, one renews with a system that integrates human activities within the biosphere. The prime goal is no longer to hide away our dejecta, nor is it to save water, but rather to recycle these in the most efficient manner towards the formation of humus in the soil and a return of its biodiversity, while also saving water.

In the Nordic countries, source-separating toilets are widely used, especially in rural areas. Their use is therefore limited to homes with a garden (or « backyard » as the garden is called in North America). By adopting EAUTARCIE's version of ECOSAN, the inhabitants of these areas will have the choice between the use of a dry toilet and a low-flush toilet discharging its waste into a septic tank reserved for black water, which needs to be periodically emptied. The question is whether, in this new context, it is still reasonable to use a source-separating toilet? When you have a small garden, composting the BLT's effluent, be it by traditional bin and windrow composting or alternate ground surface composting, is the simplest, least expensive and most effective way to protect the environment. The effluent can even be used to build a compost heap that will help heat the home. Of course, the BLT requires more frequent emptying. To avoid this chore, users have the option between a source-separating dry toilet and a low-flush toilet. In both cases, a holding tank is required, on the one hand for the collection of urine and on the other, for the collection of concentrated black water (usually in a septic tank). With a source-separating dry toilet, what is to be made of the dried faeces? Must these again be composted with plant materials and a little water (since urine has been removed)? As diluted urine is harmful to the soil if spread upon it, it becomes necessary to empty the urine holding tank as you would the septic tank, and remove the urine of one and the sewage of the other (by tank truck transport) to an impregnation and composting centre for further treatment. When you now compare source-separating dry toilets and low-flush-toilets with the BLT-type dry toilet, the choice becomes obvious. Consider the true impact of each set-up on soil life, and the monetary cost of each.

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