Recycling Greywater
in one's garden

by Joseph Országh (adapted and translated by André Leguerrier)

Laws in the absence of black water

To my knowledge, laws in France and Belgium don't recognize situations in which black water is not produced. All regulations on wastewater elimination have been established on the premise that wastewater is a combined mixture of grey soapy water (representing 70 to 80%), and black faecal water (representing 20 to 30%).

There is a certain legislative incoherence here, as current laws regulate and authorize the usage of dry toilets. In so doing, legislators have implicitly recognized the non-production of domestic black water. Yet they have omitted to adopt other legislation that addresses situations where only greywater is produced by households, considering the fact that the composition of greywater is fundamentally different from combined wastewater. Not only is this legislatively incoherent, but also scientifically invalid.

This anomaly is not only a judicial mistake, but also unconstitutional. It is discriminatory towards that part of the population that has adopted dry toilets to better protect the environment. Applying the same rules to greywater as those that apply to combined wastewater penalizes those people and exposes them to unjustifiable expenses.

The case against black water

Indeed, urine and faeces account for 99% of the bacteria, 98% of the nitrogen and 90% of the phosphorus contained in overall domestic wastewater [1].

If urine and faeces were dispersed in the soil, only nitrogen would represent a potential danger for ground waters as organic nitrogen would be oxidized into nitrates in the process. These NO_3^- nitrate ions are barely taken up by the soil, and whatever the sub-grade's geological characteristics, the ions eventually end up in ground waters, effectively polluting these with nitrates. When dispersing urine and faeces (such as sewage sludge) on land, the more efficiently such wastewater has been treated and purified, the greater the amount of nitrates that are released to the environment. In such a case, the concept of «purification efficiency» actually signifies greater pollution.

Phosphorus does not represent a risk for ground waters because in its organic form, it is easily bound by all soils. As phosphorus is transformed into PO_4^{3-} phosphate ions, the phosphates dispersed in the soil precipitate into salts that are insoluble in water, due mainly to the general presence of calcium or magnesium ions in almost all soils. Thus, when dispersing phosphorus in the rhizosphere [2], it is taken up and recycled by plants [3]. Metabolic phosphorus (i.e. as contained in human dejecta) is only harmful if and when it is treated in a sanitation plant and then discharged into a water course. When correctly infiltrated into the ground, there is no negative environmental impact.

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[1] Link: http://www.eautarcie.org/images/saineco-text-en.pdf .
[2] Link: http://www.eautarcie.org/en/09b.html#rh02 .
[3] That part of the metabolic phosphorus that is discharged with domestic wastewater is ultimately lost to sea. At the same time, phosphate mines that supply the agriculture industry are seriously depleting. Yet, when using dry toilets, all metabolic phosphorus is conserved as it is maintained within the natural phosphorus cycle.

Wastewater treatment effectively removes the nitrogen and phosphorus from the process of humus formation for the soil; in this respect, black water treatment is a major environmental nuisance.

Faecal-contaminated bacteria are only harmful to ground waters when wastewater containing black water is discharged in the environment. However, the holding capacity of most soils is relatively good with respect to bacterial contamination. The soil's natural capacity to neutralize contaminants constitutes a sort of bioremediation by the soil that one could call «pedo-remediation».

The case for greywater

Greywater contains practically no faecal-contaminated bacteria, almost no nitrogen and very little phosphorus. When selectively infiltrating greywater in the soil, these elements (virtually absent in greywater) are in no way dangerous to ground waters – whatever prior treatment the greywater received.

The only risk with greywater is a clogging of the dispersion system. Household products commonly found in greywater (for laundry, dishwashing, cleaning, and personal hygiene) would only present an environmental risk to the extent that greywater were treated and discharged into a river or other natural surface water. This is to be avoided at all cost, **even if greywater were treated!** When correctly infiltrated in the soil, even without any prior treatment, greywater is harmless to ground waters. The holding time for wastewater in sanitation plants is too short to decompose these products, and once discharged into a natural aquatic ecosystem, even weak concentrations of the resulting substances can be environmentally harmful. On this subject, see more on the following 14-minute video: http://www.youtube.com/watch?v=u9er47QA_yM.

Household products are essentially constituted of large molecules having a high electric dipole moment. Thus they have a high affinity with the inorganic particles of all types of soils. Bound to soil particles by adsorption, these products are controlled by spontaneous bacterial flora that have ample time to turn the substances into water and carbon dioxide [4]. No groundwater reserves are known to be polluted by soaps, fats and detergents, unless they have been in contact with a river (polluted by sanitation plants).

Conclusion

Given the above, infiltration of only greywater in the soil without any black water presents no risk to the environment, even without any prior treatment. Greywater becomes a risk only if discharged directly in natural surface waters, even after treatment. Greywater purification should therefore be avoided, even by means of phytoremediation [5]. Thus, once a household decides to adopt dry toilets instead of flush toilets, the residual wastewater produced by the household must absolutely not be treated unless it is impossible to correctly infiltrate greywater in the soil.

[4] In the soil, sulfur that comes from detergents (sulphates, sulphonates or $R\text{-}SO_3^-$) becomes a sulphate SO_4^{2-} that precipitates into calcium sulphate $CaSO_4$, insoluble and absolutely harmless.

[5] Link: http://www.eautarcie.org/en/04c.html.

When using a non-source-separating dry toilet [6], greywater purification is senseless, even with phytoremediation techniques. And if one is to use such techniques in dry regions, the inherent evaporation of water represents a loss for agriculture as well as for the environment.

The most rational use for greywater is by watering plants in the garden, without any prior treatment, except maybe some decanting [7].

In winter, when there is no need for irrigation water, an option is to infiltrate greywater directly into the soil with some sort of dispersion system. To prevent clogging of the dispersion system, the water would need to pass through a bioreactor called a greywater batch reactor, essentially a simple septic tank, the operation of which is described on the EAUTARCIE web site at http://www.eautarcie.org/en/04b.html#a. In summer, infiltration of greywater (always without black water) should be authorized by means of a simple soakaway.

An alternative option is to send untreated greywater into a small planted area, self-contained (without outfall), located at the lowest point of the garden. It would cover an area of about 5 m² per population-equivalent. The greywater would be conveyed to the zone under a layer of gravel or washed pebbles, under trees that take up and evaporate a lot of water, such as willows, poplars, bamboos or others. In summer, this sort of wetland would harbour lush decorative plant life.

A smart solution for greywater recycling is to put in place an artificial wetland, essentially a watertight pond of a few m³, maximum depth of 50 cm. It would serve to collect untreated greywater (not having gone through an anaerobic batch reactor from which it would acquire a foul odour). Exposed to daylight and air, such water spontaneously clarifies and settles out. Irrigation of the garden can be provided from this pond.

Alternately, by conveying greywater through three small open tanks (a few square meters each) in series, the water in the third tank will be clear enough to harbour decorative aquatic plants.

Families that use a proper dry toilet, compost their dejecta in the garden and recycle their greywater for irrigation purposes effectively and completely cease to pollute water. All water consumed by the household is returned to the water table, without pollution. Instead of penalizing such families, as is presently the case by regulating authorities, these families should be cited as examples.

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[6] Link: http://www.eautarcie.org/en/05a.html (see paragraph on « first misconception »).

[7] Many tests have been undergone on the use of untreated greywater for the watering of plants: these tend to show that household products are generally harmless to plants. However, more studies are needed to fully document what products could be harmful. To our knowledge, only chlorine bleach, hydrochloric acid and ammonia are potentially harmful to plants. Yet when used sparingly, these don't appear to be a problem. Further observations are needed.