Waste Water Treatment Plants and Sewage Sludge Disposal on Farmlands

by Christian E. Stalberg, Feb. 28, 2019

Current Stage of the System

Waste water treatment plants (WWTPs) process sewage from the residential, commercial and industrial sectors. Additionally, some WWTPs receive urban runoff from municipal stormwater systems, as well as landfill leachate that is either piped or hauled to the facility. WWTPs are centralized systems designed to serve growing population centers through expanding stormwater and sewage systems.

WWTP processing separates liquids from solids, with the liquids being discharged into waterways. The solids, called sewage sludge (aka 'biosolids'), are then treated before their disposal. Sewage sludge treatments include thickening, dewatering, digestion, composting, incineration, and drying beds. After treatment the sewage sludge can be landfilled or, most often, spread on farmland and sold as compost due to its fertilizer value (as it contains macro and micronutrients). As of 2013, about 55% of sewage solids are turned into fertilizer, most of it spread on farmland. Once applied on farms and gardens, sewage sludge breaks down into components that impact ground and surface waters, soil, air, plants and animals (through uptake). In 2004, approximately 7.1 million tons of sewage solids were generated from 16,500 WWTPs in the United States.

A large number of chemicals in use by the residential, commercial and industrial sectors are contained in the influent entering the WWTP. Current regulations only require that WWTPs test for 9 heavy metal pollutants, even though tens of thousands of chemicals are currently in use.

There are multiple problems with the current system as designed. The system is highly centralized and has high energy and materials costs that must continuously come from outside the system. Most importantly however is that we don't know which of the 85,000 chemicals that are listed on the EPA's inventory of chemicals falling under the Toxic Substances Control Act can be found in sewage sludge that is being used as fertilizer and released into the environment. A 2018 Office of the Inspector General review of the EPA's sewage sludge monitoring program identified 352 pollutants contained in sewage sludge, including 61 designated as acutely hazardous, hazardous or priority pollutants in other programs, for which the EPA either lacked data or risk assessment tools to perform a safety evaluation.

Recommendations

The following ecosystem attributes can be identified in the current system which, by applying principles of ecological succession, can be made to function more like mature stable ecosystems:

Nutrient conservation (closed-loop cycling)

> Current methods of food cropping, particularly monocultures, utilize external inputs such as fertilizers for viability, i.e. open-looped. Pre-industrial agroecological farming were closed-loop systems not requiring external inputs. Biodiversity in terms of selected food crop species and varietals along with cover cropping and animal integration allowed for self-renewing, highly

productive and stable agriculture for thousands of years. By shifting from large scale monoagricultural systems to small scale polyagroecological systems, we can eliminate the need for external fertilizer inputs. By so doing we can also eliminate the widespread contamination of the environment from spreading toxic sewage sludge on farmland.

Mineral Cycles

The current mineral cycle for modern agriculture is open-looped, with minerals for building soil micronutrients being brought in from off-site. Alternatives exist using agroecological methods of farming to cycle minerals in the soil through on-site practices including carbonation (decomposition of organic matter), hydration (watering), and microbial activation (compost teas), thereby achieving a closed-loop system.

Food Chain

Currently modern agriculture utilizes a linear system of external inputs and outputs, and sewage sludge as fertilizer is one such external input. Alternatively, using small scale localized agroecological methods, we can eliminate the need for external inputs and outputs. This can create a weblike food chain, with an on-site nutrient cycle which includes human's food and waste. Reuse of human excreta once properly treated can be both safe and highly beneficial. Of course care must be taken to remove pharmaceuticals and pathogens.

Current methods of residential sewage connected to WWTPs are open-looped systems, requiring municipal utility water for flushing and sewer for off-site processing. An alternative is to use urine-diverting compost toilets that separate liquids from solids, both of which can then be used as fertilizer on-site. Reuse of human excreta once properly treated can be both safe and highly beneficial. Of course care must be taken to remove pharmaceuticals and pathogens.

Growth strategy (how to multiply)

WWTPs and their sewer networks are designed for rapid urban/suburban growth and expansion (r-selection). By contrast, urine-diverting compost toilets can be integrated within the immediate ecosystem such that feedback – local food production performance – can lead to changes in the system (K-selection).

Stability (resistance to external perturbation)

WWTPs are subject to failure during disasters. In the event of a loss of power, sewer backups can occur. Flood events cause WWTPs to be overwhelmed causing them to release untreated sewage into the environment affecting drinking water supplies. Ecological succession would suggest replacing vulnerable centralized systems with local, on-site (distributed) treatment systems.

Entropy (energy lost)

WWTPs and their sewer networks are highly energy intensive with electricity being used for pumping systems, aeration, and equipment for the dewatering and drying of sewage sludge. Alternatively, compost toilets use negligible energy and are therefore low in entropy.

Biomass supported/unit energy flow (B/E ratio)

WWTPs and their sewer networks are highly energy intensive with electricity being used for pumping systems, aeration, and equipment for the dewatering and drying of sewage sludge. There are also embedded energy in all the materials used for the WWTP and network infrastructure. The current system has a very low B/E ratio. Alternatively, compost toilets use negligible energy for power or as embedded energy, and therefore have a very high B/E ratio.

Inorganic nutrients

The current inorganic nutrient cycle with modern monocultural agriculture is extrabiotic, depending upon external inputs. By contrast, the inorganic nutrient cycle using polyagroecological methods is intrabiotic.

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