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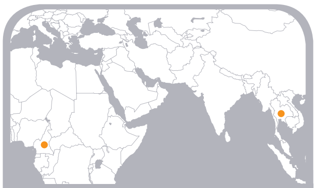
Layout of yard-scale faecal sludge drying beds vegetated with indigenous plants. Researchers tested the ability of antelope grass and papyrus to serve as supporting material for faecal sludge treatment in Cameroon. Photo: Ives Kengne

Productive treatment of faecal sludge: from waste to fodder and profits


Case studies featured here were conducted in: Cameroon and Thailand

Policy message

- On-site sanitation systems (e.g. latrines) are widespread in developing countries, but sustainable systems for treating the sludge from them are lacking.
- Dumping untreated faecal sludge onto land or into drains and watercourses puts public health at risk.
- Planted sludge dewatering beds (PSDBs) are a cost-effective and technically feasible approach to sludge dewatering, stabilisation, and mineralisation.
- Due to their long-term sustainability and extremely low operating and maintenance costs, PSDBs are an appropriate and affordable technology for treatment of FS in developing countries.
- The system also provides added-value products such as compost and fodder to increase the food security and livelihoods of local people.

In developing countries, lack of low-cost, efficient treatment technologies commonly results in faecal sludge (FS) from domestic on-site sanitation systems (e.g. latrines) being dumped untreated onto the land or into drains and watercourses. This puts public health at risk and harms the environment. Sludge drying beds planted with emergent macrophytes (plants that grow in shallow water but have their stems and leaves above the water surface) are a cost-effective and technically feasible approach for treating sludge. They also produce plants that can be used as feed for livestock and biosolids that can be applied as compost to cropland, increasing agricultural productivity.

Billions of people have little or no access to sanitation

Centralised sewage collection and treatment systems are rare in the developing world and are likely to remain so for the foreseeable future. Globally, 2.5 billion people lack access to improved sanitation, including 1.2 billion who have no facilities at all. Increased drought and flooding as a result of climate change will only make matters worse. The world is not on track to meet the Millennium Development Goal of halving the proportion of people without sustainable access to basic sanitation by 2015 (JMP 2008). There is a need to greatly accelerate progress in improving sanitation, particularly in sub-Saharan Africa and southern Asia. Poor sanitation increases disease incidence and consequent loss of earnings and dignity, important factors contributing to poverty.

Better faecal sludge treatment improves health and the environment

Discharge of untreated faecal sludge directly into the environment has major health impacts. One gram of fresh faeces from an infected person can contain around ten million viruses, up to a billion bacteria, and 100,000 worm eggs (Feachem et al 1983). Untreated faecal sludge contaminates ground and surface water, and can provide breeding sites for flies and mosquitoes. It also

Featured case studies

PSDB for treatment of septic tank sewage in Bangkok

In Bangkok, Thailand, PSDBs planted with narrow-leaved cattails (Typha angustifolia) successfully treated septic tank sewage. The optimum solids loading rate was 250 kg total solids/m2 of bed per year, with the effluent held in tanks for six days. The biosolids accumulated in the PSDB units to a depth of 80 cm over the seven years of operation, and no clogging occurred (Koottatep et al 2005).

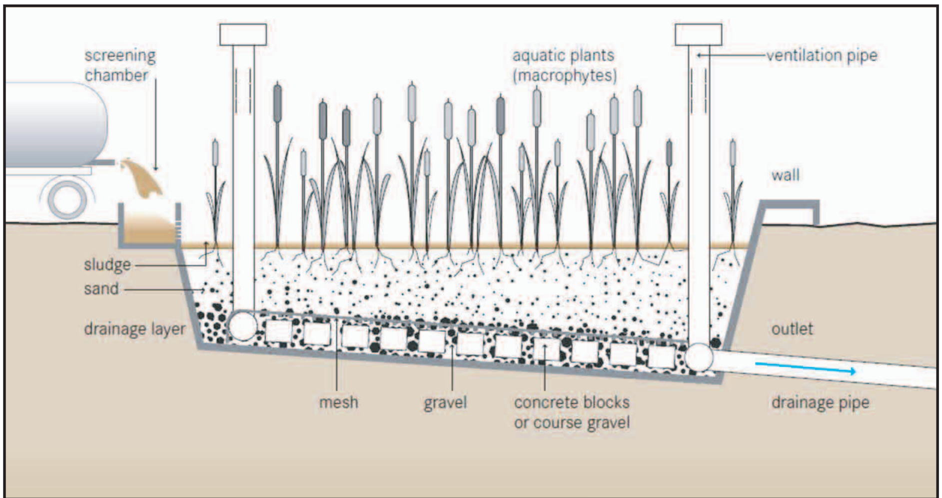
Growing fodder plants on PSDBs in Yaounde, Cameroon

In Cameroon, PSDBs planted with antelope grass (Echinochloa pyramidalis), a highly prized fodder, have been used at yard-scale to efficiently treat faecal sludge at a loading rate of 200 kg of solids/m2 of bed per year. Biomass yield was approximately 750 t fresh matter/ha per year, three times as much as in natural habitats (Kengne et al 2008). The biosolids generated contain high concentrations of nitrogen (>2%) and phosphorus (>2.3 %) and very low concentrations of heavy metals. Storing the biosolids for six months reduced parasite populations to a level considered safe for agricultural use based on the WHO guidelines (Kengne et al 2009).

creates a smelly and unsightly environment. Improved sanitation alone can reduce rates of diarrhoeal diseases by 32%–37% (Mara et al 2010). In addition to its impact on health, adequate sanitation, together with good hygiene and safe water, generates both social and economic benefits, including lower health-system costs and fewer days lost at work or at school through illness. In total the prevention of sanitation and water-related diseases could save some USD 7 billion per year in health system costs. One dollar spent on sanitation could generate about USD 10-worth of economic benefits (Mara et al 2010).

Planted sludge drying beds provide efficient, sustainable faecal sludge treatment

Appropriate and affordable treatment technologies greatly contribute to reducing anarchic discharge of faecal sludge. Planted sludge drying beds (PSDBs) are a viable way to treat faecal sludge in developing countries. The system effectively separates solids and liquids in faecal sludge, and can handle larger amounts of solids than systems such as activated sludge or waste stabilisation ponds. They retain 90–96% of solids and eliminate 78–99% of chemical and organic pollutants. The system efficiently removes faecal parasites, trapping almost 100% of helminth eggs at the surface of the filtering matrix (Koottatep et al 2005). Note, however, that performance is influenced by several factors, including climate and the quality of the sludge applied. The effluent water may need further treatment before being released into surface water, but it can be used directly for restricted irrigation.



Layout of a planted sludge drying bed. Faecal sludge is applied to the bed. Solids are retained on the surface of the filtering matrix, where they are mineralised, while liquids drain out of the system for further treatment (Tilley et al 2008).

Wide choice of plants

A wide range of emergent plant species can grow in the watery, muddy, and anaerobic conditions of PSDBs, including reeds (Phragmites australis), cattails (Typha spp.), papyrus (Cyperus papyrus), and antelope grass (Echinochloa pyramidalis). The most important role of these plants is in stabilising the soil surface to avoid the formation of erosion channels. The movements of the plants and the growth of their roots creates and maintains drainage pathways. A considerable amount of nutrients are exported during harvest and bed desludging (Kengne et al 2008). The plant chosen should be readily available, grow and multiply well, have high transpiration capacity, tolerate different water levels, low and high pH and salinity, have a deep growing rhizome and root system, resist insect attacks, and be easy to plant.

By-products generate income

Plants grown on the dewatering beds can be fed to livestock. The biosolids can be composted with plant material and used as fertiliser in agriculture and aquaculture. The effluent can be used to enrich fish ponds to increase the growth of the phytoplankton on which fish feed. The system thus has the potential to generate substantial revenue to help cover part of the operational and maintenance costs of treatment plants. Faecal sludge has a high concentration of organic matter and nutrients, especially nitrogen and phosphorus. It also acts as a soil conditioner, improving soil structure for plant roots. Sludge from pit latrines and septic tanks contains very little heavy metal (Kengne et al 2009). However, the sludge may need to be stored for at least six months or composted to eliminate pathogens and make it safe to handle.

Careful planning ensures efficient operation

Incorrect construction and operation of the beds can result in short operating life and problems with dewatering efficiency, vegetation growth, mineralisation and odour. The size of the PSDB should be based on the quality and amount of sludge to be treated and take into account climatic factors that affect the dewatering rates. Low solid loading rates (SLRs) of 30–80 kg total solids/m2 per year have been suggested for the treatment of activated and digested sludge in Europe, but PSDBs in warm, tropical regions can be loaded at much higher rates (100–250 kg total solids/m2 per year) (Koottatep et al 2005, Kengne et al 2008). If the plants wilt when beds are loaded once a week, smaller amounts of sludge can be added two or three times a week. Water can also be kept in the beds for a week before being released, thus contributing to the elimination of nitrogen by denitrification.

Major challenges need to be addressed

Despite the promise of PSDBs, several aspects need further in-depth investigation. These include: identification of suitable plants that are resistant to insect pests and tolerant of salinity and other abiotic stresses; treatment of effluent; safety of by-products of the treatment plant as well as their marketing; performance of the system when operated at large scale; and cost-benefit analysis of the system.

Definitions

Biosolids: faecal sludge accumulated on the top of PSDBs. They are a valuable organic manure that can be used as fertiliser and to improve soil structure.

Faecal sludge: sludge of variable consistency collected from on-site sanitation systems such as latrines, non-sewered public toilets, septic tanks, and aqua privies. It comprises varying concentrations of settleable or settled solids and other non-faecal matter. It differs from the sewage sludge which generally refers to sludge produced in wastewater treatment plants.

Planted sludge-drying beds: an artificial system composed of selected media supporting emergent vegetation constructed to dewater and humify sludge. The sludge is spread over the system and accumulates there for up to 8–10 years, depending on the loading rate, the capacity of the system, and the mineralisation rate.

Solid loading rate: total solid weight of faecal sludge applied to the system per unit surface area and time. Used as a design criterion for faecal sludge treatment plants.

Faecal sludge being discharged without any treatment in Douala, Cameroon. Each day, large amounts of faecal sludge collected in this town are discharged into the environment, despite the fact that it contains pathogens and nutrient concentrations 10 to 100 times higher than in domestic wastewater. Photo: Ives Kengne

The plant *E. pyramidalis* is very popular in Cameroon, where it may be profitably sold at markets as animal feed. However, it is very scarce during the dry season. Faecal sludge treatment using this plant will improve its availability throughout the year and generate income. Photo: Marie-Madeleine Ngoutane

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Policy implications of NCCR North-South research

Sanitation systems in developing countries rarely address faecal sludge treatment

Current on-site sanitation facilities in developing countries rarely address the issue of how to treat faecal sludge once they are emptied. However, the most effective intervention against water and sanitation-related diseases is safe excreta disposal.

But successful approaches to faecal sludge treatment exist

Research supported by the NCCR North-South programme has developed promising technologies for faecal sludge treatment, such as PSDBs. This ecotechnology is cost effective and is gradually gaining acceptance around the world as more knowledge is accumulated on its design, construction, and operational functioning. The income generated by selling by-products of faecal sludge treatment may attract and encourage the involvement of the local private sector in running such facilities, and transform faecal sludge from a disposal problem into a profitable commodity.

More research is needed

Advances in decentralised faecal sludge treatment provide an opportunity to reduce the threat posed by the discharge of untreated faecal sludge into the environment. However, more data are needed to better design low-cost, efficient treatment technologies. Governments and donor agencies should promote research aimed at optimising existing technology as well as implementing successful approaches.

Further reading

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