CRBOM Small Publications Series No. 26

Out of sight, out of mind - the forgotten merits of septic tanks

by

Thi Thanh Van Ngo

Center for River Basin Organizations and Management,
Solo, Central Java, Indonesia

August 2010

The *'Small Publications'* are intended for knowledge-sharing and dialogue. In some cases they may present facts, information and lessons learnt. In other cases, they provide news, opinions, ideas or open questions for discussion.

They express the opinions of the author(s) and not those of CRBOM.

They can be freely copied and disseminated.

Contributions are welcome, in English or in Bahasa Indonesia.

The author: Associate professor, dr. Thi Thanh Van Ngo,
Head of Water Resources Economics Department,
Water Resources University, Hanoi
ngo_thvan@yahoo.com

CRBOM
Center for River Basin Organizations and Management,
Solo, Central Java, Indonesia
www.crbom.org
info@crbom.org

Contents

Glossary

Anaerobic: Without access (or exposure) to free oxygen. Opposite of aerobic, which means with access to, or relying on access to free oxygen

Assimilative capacity (of a watercourse or a wetland): A measure of the extent to which the watercourse is able to accommodate supplies of BOD and nutrients without significant environmental degradation

BOD: Biological oxygen demand, normally expressed as mg of oxygen per litre consumed for mineralization of organic compounds over a period of 5 days

Eutrophication: Excessive aquatic growth caused by a high contents of nutrients. Eutrophication can cause oxygen depletion, killing of fish and bed organisms, and foul smell

Nutrients (in wastewater and water bodies): Nitrogen and phosphorus compounds, appearing as solutes or suspended particles. Nitrogen can be degraded to free nitrogen, N2, and removed from the aquatic environment to the atmosphere (where it occurs naturally, comprising 78 percent of the atmosphere). Phosphorus cannot be removed as such, but can be consumed by bacteria or algae, or can be deposited with bed sediments

Self-cleaning: The removal of BOD and nitrogen (and perhaps phosphorus, by sedimentation) that takes place during the transport of wastewater in sewers, drains, canals, ponds and wetlands. Self-cleaning is related to the hydraulic capacity of the conveyance system (the longer retention time, the better), access to oxygen (the more the better), and the sedimentation rate (the higher the better, provided that the sediments are in turn appropriately disposed of). Self-cleaning can be substantial, but is difficult to quantify (and control)

Septic (literally): Infected with bacteria

Summary

Septic tanks were never intended for densely populated urban areas. As it is, however, they are now found everywhere. This paper offers some observations on making the best out of living with our septic tanks.

Hanoi serves as an example. It is estimated that this town discharges 400-450,000 m3/day of domestic wastewater, plus around 260,000 m3/day of industrial wastewater, only 10% of which is treated by septic tanks. One of the immediate ways to significantly reduce the level of pollution from septic waste in Hanoi is to empty the septic tanks regularly, and dispose of the raw sludge properly. Hanoi shares its sewage disposal problems with many other towns in Asia.

Septic tanks have several merits, including versatility, financing, and returns on investment - in a local as well as a basin-level perspective.

There is a need of better knowledge about cause-effect relationships and management options for places like Hanoi - and presumably other Asian cities. This will allow for better decisions and prudent investment.

1 Introduction

Septic tanks were never intended for densely populated urban areas. As it is, however, they are now found everywhere. Without maintenance, they become filled with sediments and have no effect whatsoever some years after they are built. The same is the case if they are overloaded.

Proper maintenance may not in itself provide a safeguard against water pollution from urban areas, but can still be a highly practical and cost-effective measure in support of reduced pollution loads.

This paper provides some observations on making the best out of living with our septic tanks.

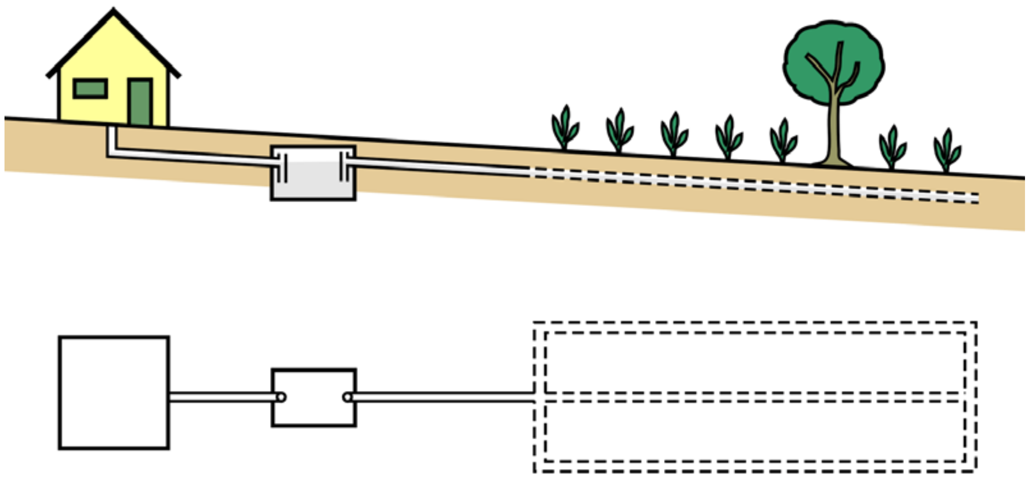
2 Septic tank basics

Description

The septic tank was invented by John Louis Mouras (France) who got it patented in 1881 after a successful 10-years pilot test. It is simple and robust and requires little maintenance and no electricity. Today, it is widely used anywhere.

The '*septic system'* was intended for wastewater disposal from single households in sparsely populated rural areas. It consists of the septic tank itself, an infiltration area, and connecting pipes. The tank provides conditioning of the raw wastewater by retaining solids and by anaerobic digestion of organic components, which are hereby broken down into gases and solutes.

Figure 1: A septic system (side view and top view)



A well functioning septic tank converts the raw wastewater into

- conditioned, anaerobic wastewater, containing dissolved organic matter and nutrients;
- sediments and floating debris (foam and grease) that must be removed manually (and disposed of in an orderly way); and
- gases, including methane and hydrogen sulphide.

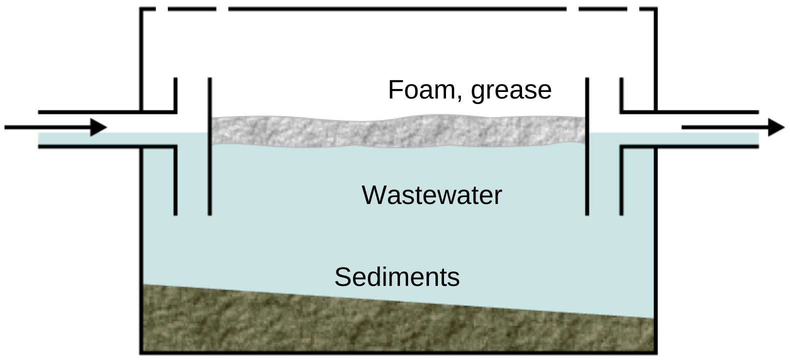
The septic tank can reduce the contents of suspended solids, organic matter, nutrients and bacteria in the raw wastewater. The effluent can decompose further quite readily when exposed to oxygen or to soil bacteria. Until such further decomposition has taken place, however, the effluent can cause foul smell, and be poisonous to fish, if discharged into surface water bodies. There is also a risk of groundwater contamination if the effluent is disposed of by infiltration.

Design

A basic design is shown below. Much more fancy solutions are available.

The hydraulic capacity of the tank must reflect the flow of wastewater - the larger, the better, but also the more expensive. As a rule of thumb, the volume should equal two days of flow.

Figure 2: A simple one-chamber septic tank (side view)



Operation

An important operation requirement is the removal of sediments (as well as foam and grease) as often as this is required. Otherwise, the active volume of the tank will disappear. Cleaning may be needed every two years, but the interval can be much longer (or shorter), depending on the tank capacity (the larger the better) and the wastewater composition (particularly the amount and character of suspended solids).

Performance

The original purpose of a septic tank was to convert or retain suspended solids that would clog the infiltration system. In addition, the tank can provide a certain pre-treatment by converting (and even, to some extent removing) organic compounds and nutrients, as well as reducing the contents of bacteria. These positive side effects are particularly relevant in places where the effluent is directed to surface water bodies and not to infiltration - as it is the case in densely populated urban areas in Asia.

3 Example from Hanoi

(This chapter compiled from Van Ngo, Jan 09 and Fink, Jul 01)

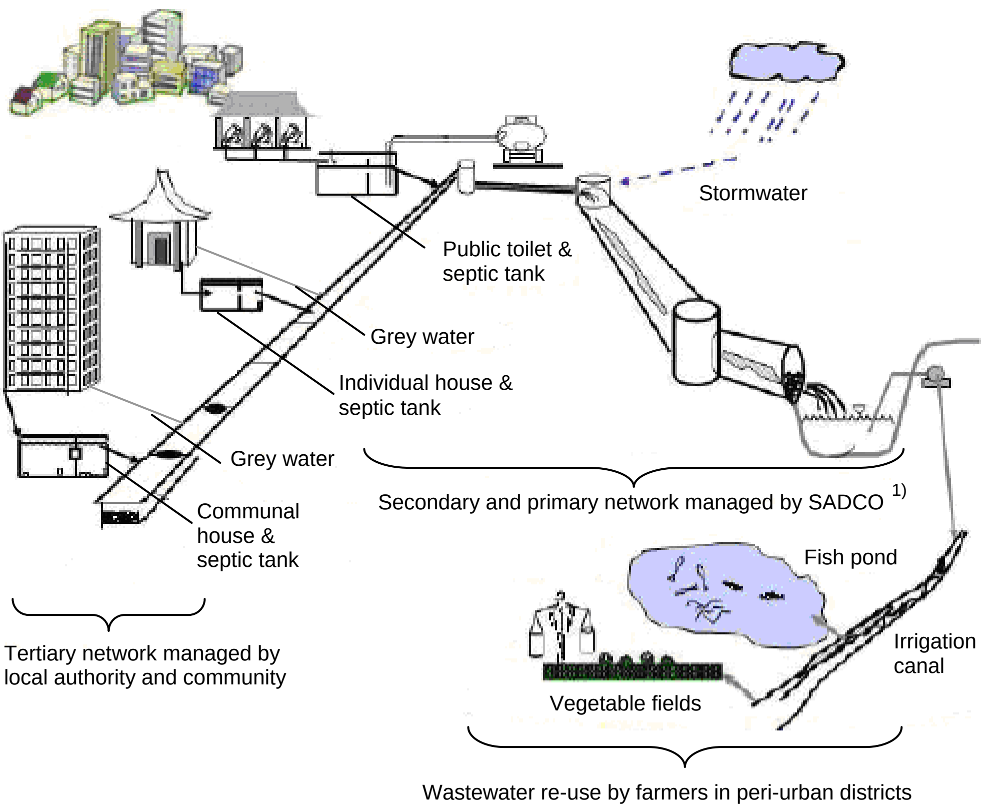
The Emperor Ly Cong Uan founded Hanoi in 1010. Its location in the centre of the Red River Delta is advantageous in every respect: Good road, railway and airline connections, as well as access to human and natural resources have supported a rapid growth.

During 1995-2003, when Viet Nam implemented its *'open-door'* policy, Hanoi's population leaped by about 30%, to about 3 million people. This growth was accompanied by an increase in resource consumption, sewage generation, and environmental degradation.

It is estimated that (by 2008) Hanoi discharges 400-450,000 m3/day of domestic wastewater, plus around 260,000 m3/day of industrial wastewater, only 10% of which is treated. Therefore, most of the five rivers and 11 lakes and ponds in Hanoi are severely polluted - a pollution that is all the more dramatic considering that Hanoi's water system, besides being a wastewater reservoir, produces over five tons of fish per month from each hectare of pond.

Hanoi's sewerage and drainage system was constructed in 1905-1945. It was designed to serve a population of 400,00. Nowadays it covers an area of about 1,000 ha in the central part of the old city, and only 35-40 percent of the urban population benefit from the system.

Figure 3: Hanoi's sewerage and drainage system



[1)] *SADCO: Hanoi Sewerage and Drainage Company*

Mr Anh

A household survey in 1999 included mr Anh, a carpenter, living and working in an old limestone brick house in central Hanoi. His house was built before the current roads and wastewater drains were constructed. Consequently, the floors are lower than the road and any rains flood directly into his workshop. Mr Anh explained that he wanted to build a new toilet because the septic tank was inadequate - actually it was an old bomb shelter connected to the sewage pipelines.

(Fink, Jul 01)

Drainage in Hanoi has always been a challenge. In order to protect the city from flooding, considerable efforts have been necessary to establish a drainage canal system along the Red River and the To Lich River. Nonetheless, until nowadays, many streets do not have a drainage and sewage system or simply suffer from decay of sewers, which altogether often result in flooded neighbourhoods during the rainy season.

Hanoi's sewerage and stormwater drainage systems are combined. While most of the inner parts of the city have access to an underground drainage network, the suburbs still rely entirely on open drains. Most of the system suffers from small dimensions and (due to the topography) low slopes, causing excessive siltation.

Wastewater from households is supposed to be collected in septic tanks, where the water is treated before being disposed into the drainage system. Large industrial plants usually operate their own water supply and wastewater disposal system. A large proportion of human waste in Hanoi goes directly to the waterways without treatment. In a number of cases, toxic sewerage is disposed into the rivers and ponds of the city.

One of the immediate ways to significantly reduce the level of pollution from septic waste in Hanoi is to empty the septic tanks regularly, and dispose of the raw sludge properly.

Hanoi shares its sewage disposal problems with many other towns in Asia. Two examples are described below.

Phnom Penh and Vientiane - two capitals on the Mekong

Both towns are low-lying and flat, with high groundwater tables and topographic impediments to stormwater drainage and sediment flushing. Both are partly (but far from entirely) served by sewers. Septic tanks are commonly used, along with many irregular domestic and industrial discharges. Phnom Penh has no sewage treatments plants, while Vientiane has one, serving some part of the town.

Both towns have adjacent wetlands that receive partly treated or raw wastewater: The That Luang Marsh just east of Vientiane, draining into the Mekong downstream of the town, and the Boeng Cheung Ek wetlands just south of Phnom Penh, draining into the Tonle Bassac downstream of the town.

Like Hanoi, these towns depend on a combination of septic tanks and *'self-cleaning'* in the disposal system - sewerage network, ponds, ditches, canals and wetlands. Both towns would benefit from a better coverage by septic tanks and improved operation of existing ones.

4 Some merits of septic tanks

For various (environmental and hygienic) reasons, septic tanks are not suited for direct disposal into surface water bodies. On the other hand, if faced with a choice between disposal of raw wastewater and pre-treated wastewater, the latter would be preferred - particularly if the septic tanks have been established already.

New housing areas should be built with separate sewers, suited for collection for comprehensive treatment and orderly disposal, now or at a later stage. Still, they should be provided with septic tanks, unless a better treatment option is available or will become available in the short term.

Some aspects to keep in mind are listed below.

- The on-site processing provided by household septic tanks can improve the *'self-cleaning capacity',* or further degradation of the wastewater (BOD reduction and, possibly, nitrogen removal) during subsequent transport.

- Septic tanks can remain useful also if combined with central, secondary treatment at a later stage, by reducing the load of pollutants and sediments.

- Septic tanks are more versatile than centralized treatment, as far as simple wastewater from households is processed separately from more demanding wastewater from clinics and industries, rather than mixing everything before treatment. This relates also to a system that combines on-site treatment (by septic tanks) with central, secondary treatment.

- Orderly maintenance of septic tanks may comprise cleaning and inspection, say once every two years. This will require some financing - but the financing can be simple. For example, the maintenance can be provided by (public or certified private) operators and charged directly by these to the households. Cross-subsidies can be considered in favour of low-income households.

- Orderly maintenance can be combined with monitoring of effluents and sediments.

- Orderly maintenance can be combined with awareness-building to promote good practices within water utilization and wastewater generation, perhaps supported by economic incentives.

- From an investment point of view, septic tanks (and introduction of orderly maintenance) will have a flat relation between the investment and the cost-benefit ratio - the effect, in terms of *'pollutants removed per dollar',* will increase evenly along with the investment - roughly spoken, the returns on the first dollar spent will not be much less that the returns on the last dollar spent - as compared with concepts that require huge investments *'up front'* before any value is produced.

- Incentives, such as green labelling, can be considered in support of good practices, possibly attracting lead industries and hotels. Perhaps there is even a scope for sponsorships.

5 Discussion

Water quality relate to the river basin level of management, with obvious basinwide implications related to flow rates, sewage loadings and environmental impacts. The ancient concept of withdrawing raw water upstream and discharging the wastewater downstream is not viable today. Assessment of costs and benefits should, ideally, cover an entire river basin, rather than the town itself.

A lot of today's knowledge about sanitary engineering and sewage treatment origins from the West - and hereby from a context that is quite different from many Asian cities - both in terms of climate and in terms of the culture of water use. There is a need of better knowledge about cause-effect relationships and management options for places like Hanoi - and presumably other Asian cities. This will allow for better decisions and prudent investment. Some knowledge gaps are suggested below.

Knowledge gaps

Better knowledge is required about

- the actual existing urban sewage disposal and the potential for upgrading;
- the actual performance of septic tanks, as a function of capacity and loading;
- the *'self-cleaning capacity'* - the decomposition of wastewater in sewers, drains, canals, ponds and wetlands - and how to maintain or improve it without adverse side effects;
- the occurrence, origin and control of *'hard pollutants'* such as drug residues, heavy metals, and polychlorinated compounds - which are difficult to remove, and which can adversely affect the options for sludge disposal (by contaminating otherwise harmless sludge), and/or which may end up in edible fish;
- the assimilative capacity of water bodies, including wetlands that are exposed to increasing wastewater loads, and which may possibly, for that reason, deteriorate dramatically at some stage; and
- treatment costs and benefits, in a local and a basinwide perspective.

It is likely that if there will be a water crisis in the future, it will not come because of actual physical scarcity of water, as many predict at present, but because of continuing neglect of proper wastewater management practices. Continuation of the present trend will make available water sources increasingly more contaminated, and will make provision of clean water more and more expensive, as well as more complex and difficult to manage.

Asit K Biswas, in ADB (Nov 07) page 16

References

(All references are available from the Internet)

ADB (Nov 07): Asian Water Development Outlook 2007: *'Achieving water security for Asia'*

Bounds, T R (97): Design and performance of septic tanks, in *'Site characterization and design of onsite septic systems',* ASTM STP 901, M S Bedinger, A I Johnson and J S Fleming, Eds., American Society for Testing Materials, Philadelphia

Fink, Sasha (Jul 01): The sustainability of toilets in Hanoi, Vietnam. International Journal of Economic Development

Gerrard, Pauline (04): Integrating wetland ecosystem values into urban planning: The case of That Luang Marsh, Vientiane, Lao PDR. Published by LNMC, STEO, IUCN and WWF under the project *'Integrating Wetland Economic Values into River Basin Management'*

Goonetilleke, Ashantha and Les Dawes (Sep 01): Audit of septic tank performance. Proceedings of the Conference *'On-site '01 - Advancing on-site wastewater systems'* (ed. Patterson, R A), pp 155-162

Irvine, Kim N (Sep 07): The role of Phnom Penh's wetlands in sustainably treating sewage discharges to the Mekong/Bassac river system. Department of Geography and Planning, Buffalo State, State University of New York

IUCN (Jul 04): That Luang Marsh, Lao PDR - the importance of wetlands for urban populations. Case studies in wetland valuation #10

Van Ngo, Thi Thanh (Jan 09): The existing sewerage and drainage system in Hanoi. Zum Thema no. 63, TU International, Technische Universität Berlin

**Center for River Basin Organizations and Management,
Solo, Central Java, Indonesia
www.crbom.org, info@crbom.org**