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Constructed wetland at Phi Phi Island, Thailand.
Photo: Thammarat Koottatep

NCCR north south

Sustainable sanitation in urban centres in Southeast Asia

Case studies featured here were conducted in Thailand

Policy message

- Many wastewater treatment systems in urban and peri-urban Southeast Asia are poorly operated and maintained, resulting in severe water pollution.
- Trouble-free, attractive and efficient decentralised alternatives include ABRs and CWs used for both households and communities. Linking them in a chain removes pollutants completely from wastewater.
- Needs include: raising awareness of decentralised wastewater management; supporting policies and regulations; identifying financing mechanisms and incentives; building capacity to plan, implement, operate, and maintain systems.

Several cities in Southeast Asia have installed centralised sewerage systems but most lack the funds to operate and maintain them properly. As a result, untreated or poorly treated wastewater finds its way into nearby water bodies. A possible solution is to treat wastewater in a decentralised way. Suitable technologies include "anaerobic baffled reactors" (ABR) and "constructed wetlands" (CW). These simple, effective techniques can reduce the problem of wastewater at an affordable cost, at the same time as creating aesthetic values for the community. Policymakers require that alternative treatment technologies be backed with sufficient technical knowledge and information about their applicability. This issue of *evidence for policy* suggests that they could be widely adopted throughout Southeast Asia.

A decentralised alternative

In recent decades, poor sanitation services and water pollution have become more serious in the Greater Mekong Sub-region in Southeast Asia. Human health and well-being depend closely on the effective management of excreta, wastewater, and solid waste, as well as drainage and water supplies. Access to adequate sanitation is a priority for socio-economic development in developing countries. But centralised wastewater management as currently practised in many cities in the region is not successful because of its high construction and maintenance costs. A great deal of wastewater bypasses these systems and is discharged untreated into the environment. Due to the limitations of centralised wastewater treatment approaches in developing countries, especially the huge cost of the sewage system, decentralised approaches should be considered.

Decentralised wastewater treatment is a valuable alternative to conventional centralised management for developing countries because it enables both solid and liquid fractions of domestic wastewater to be treated close to their origin. It is low cost, simple to operate, and may generate a revenue for its operators from the reuse or recycling of its products. Laboratory and pilot-scale research on two such

Featured case studies

Case study 1: Baan Pru Teau, Phang Nga Province, Thailand

Baan Pru Teau is a newly built village with 80 households, intended for the victims of the 2004 Indian Ocean tsunami. The "black water" from the septic tanks and "grey water" from the households are treated by three constructed wetland cells in series (Figure 3). The three cells have a total surface area of 220 m^2 and are 0.6 m deep. They can treat 12 m^3 of wastewater a day, removing organic compounds and nutrients in compliance with Thai effluent standards, so preventing water pollution. Local people value the constructed wetland not only because it treats their wastewater, but also because it is the only park in the village.

Case study 2: Phi Phi Islands, Krabi Province, Thailand

The Phi Phi Islands are located between the large island of Phuket and the western coast of the mainland. Phi Phi Island is one of the country's top tourist attractions and receives up to 1.2 million tourists per year. Wastewater from hotels, households, and commercial units is treated by a series of constructed wetlands in a design that resembles a giant butterfly fluttering next to a flower (Figure 4). The whole "butterfly" can treat up to 400 m^3 of wastewater a day, meeting Thai effluent standards. Because of its special aesthetic design and its lack of bad odours, it has become another tourist attraction on the island as the only park in the middle of dense hotels and resorts.

technologies – anaerobic baffled reactors and constructed wetlands – in Thailand and Vietnam show that they can treat domestic wastewater to satisfactory levels at a reasonable cost.

Anaerobic baffled reactor

The anaerobic baffled reactor (Figure 1) is a modified septic tank with various advantages over a conventional septic tank or anaerobic filter. It improves the physical removal of suspended solids and enhances the biological conversion of dissolved organic contaminants. Benefits of the anaerobic baffled reactor include: a high degree of sludge retention, a high tolerance to shock loads, and stable reactor performance.

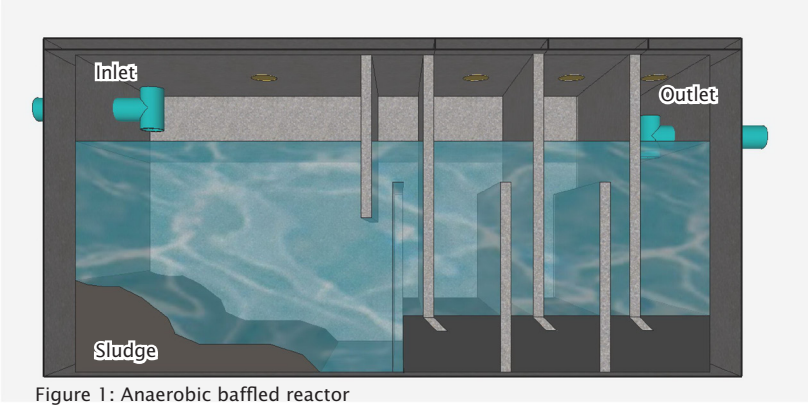

Figure 1: Anaerobic baffled reactor

In tests, a laboratory anaerobic baffled reactor removed 72–90% of the contaminants as measured by a test known as "chemical oxygen demand". A pilot system removed even more: 78–94%. This compares with only 50–60% for normal septic tanks.

An anaerobic reactor is easy to build, operate and maintain, and it is economically viable. The construction costs of a full-scale anaerobic reactor in Vietnam and Thailand were US$ 150–270 per cubic metre of reactor, or $35–70 per person served.

However, anaerobic reactors are not able to remove enough nutrients and pathogens to be in compliance with Vietnamese and Thai domestic effluent standards. Further treatment is required before discharging the effluent into streams. Anaerobic baffled reactors' effluent should be further treated by an appropriate system such as a sand filter, an anaerobic filter, or constructed wetland.

Constructed wetland

Such treatment is possible with a constructed wetland (Figure 2). This is a "natural" or "ecological" treatment system that uses vegetation such as cattails (*Typha angustifolia*) and common reeds (*Phragmites australis*). It has been successfully used to treat a wide variety of wastewaters, such as domestic wastewater, industrial effluents, urban and agricultural storm water runoff, and faecal sludge. There are three types of constructed wetlands known as free water surface systems (FWS), subsurface flow systems (SSF), and vertical flow systems (VF).

FWS and SSF can adequately remove biological oxygen demand, total suspended solids, and faecal coliforms and these types of wetlands historically have been the standard design. However, there is growing interest in nutrient treatment and application of vertical-flow constructed wetlands or hybrid systems.

In tests, constructed wetlands proved efficient as their discharge has organic material concentrations as low as 15–30 mg/litre (measured by the "biochemical oxygen demand" test) and 13–23 mg/litre of suspended solids. Research showed that a surface area of 2.5–4 m^2 per person is required, costing an average of

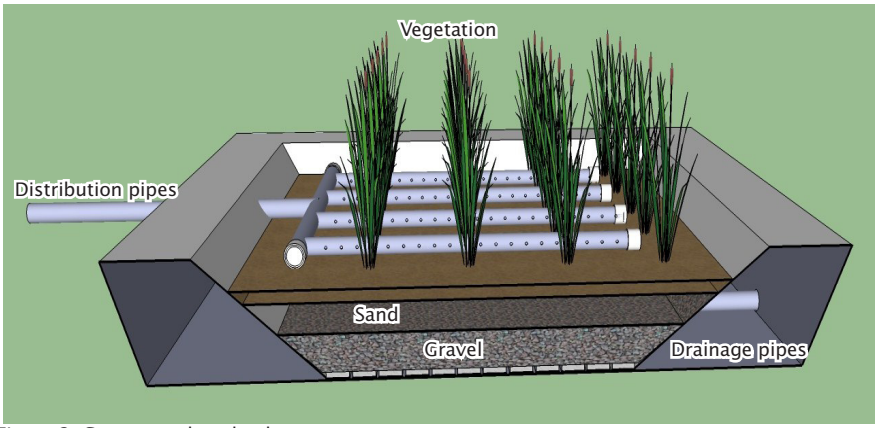

Figure 2: Constructed wetland

$60–120 per person (excluding the cost of land). Apart from their relatively low costs, constructed wetlands offer aesthetic values: they consist of a scenic green area instead of a series of concrete tanks and machines in an urban setting. This makes it easier to gain local people's acceptance of wastewater treatment systems.

However, problems may occur if the system is overloaded or if pre-treatment is ineffective: the filter bed may become clogged, plants may die off, and unpleasant odours may be emitted.

Lack of awareness

Although decentralised wastewater treatment has many benefits, it is not widely known, and few plants have been built in Southeast Asia. This may be because decision-makers do not yet think of decentralised technologies as being state-of-the-art, and they fear the public may not accept them. But the need is enormous, the targeted capacity of treatment systems is critical, and few are aware of or understand the technologies. Reasons include:

- The link between needs and supply is weak.
- There is a lack of realistic financing schemes.
- There is need for support for a change in the current approach.
- Communication among different key stakeholders is poor.

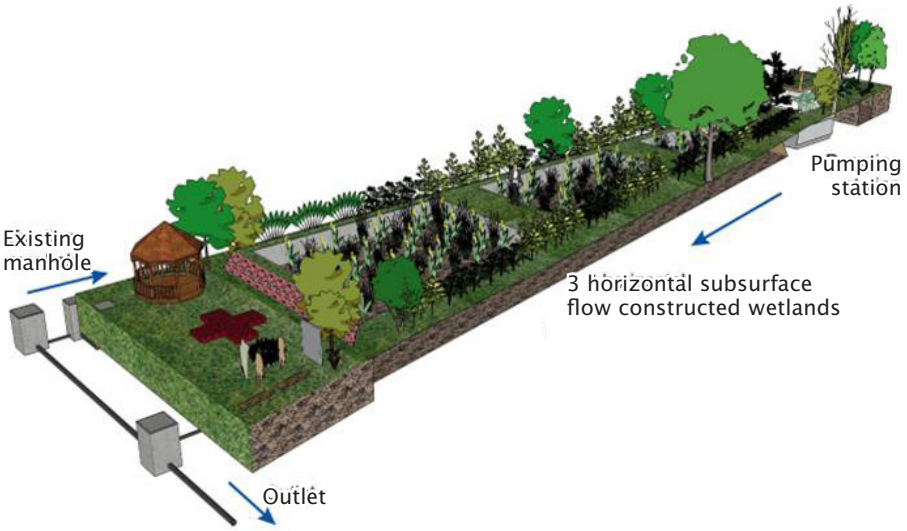

Figure 3: Constructed wetland at Baan Pru Teau

Definitions

Decentralised wastewater treatment

Decentralised wastewater systems, often called "septic" or "onsite" systems, treat wastewater close to the source, typically on the property of individual homes or businesses. It includes the system serving clusters of individual homes, large capacity septic systems, and small treatment systems (package plants) which typically require small pipes for domestic wastewater collection and treatment closer to the source. To improve treatment performance of the conventional septic tank, the effluent can be further treated by installing anaerobic baffled reactors or constructed wetlands.

Centralised wastewater treatment

Centralised wastewater treatment systems entail large-scale wastewater treatment far away from its source. They require massive pipes to collect the domestic wastewater from individual homes or businesses and deliver it to treatment plants. Limitations of centralised wastewater treatment include that it requires big investments in sewerage systems, a large land area, well-trained experts to operate the systems, and high operational and maintenance costs. Thus, such systems cannot fully address the wastewater problems in densely populated urban areas of developing and transition countries.

Figure 4: Flower and butterfly constructed wetland at Phi Phi Island

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Policy implications of NCCR North-South research

- The anaerobic baffled reactor is an efficient, robust, and cost-effective technology for the pre-treatment of heavily polluted domestic wastewater. It is suitable for onsite treatment at source.
- Constructed wetlands are an efficient post-treatment system that (unusually for a wastewater treatment system) has aesthetic value. Constructed wetlands can treat the effluent which has been pretreated by the anaerobic baffled reactor.
- Linking the two processes in a chain is the most effective way to completely remove organic compounds, solids, and nutrients from wastewater at a reasonable cost, meet effluent discharge standards, and gain the aesthetic beauty of wetland vegetation.
- Appropriate institutional and legislative frameworks are needed to plan and implement such decentralised treatment on a large scale. Partnerships are needed between individual homeowners, private service-providers, local and regional authorities, research institutions, and non-governmental bodies in order to share knowledge and skills and implement initiatives.
- Suitable financing mechanisms are required to support decentralised wastewater treatment and to provide incentives for different parties to implement them.
- Additional elements needed to raise public awareness and acceptance of the decentralised wastewater treatment include replicable models for addressing community needs and managing resources, options for organisational management and governance, and strategies for advocacy, government relations, and public outreach.

Further Reading

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