TECHNICAL ENQUIRY
SANITATION SYSTEMS FOR INDONESIAN URBAN SLUMS

DEW Point
DEVELOPMENT RESOURCE CENTRE
ENVIRONMENT – WATER – SANITATION

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Enquiry A0165 – Sanitation systems for Indonesian urban slums

Description

What I am also looking for is experience from other regions of improved sanitation for poor communities living above lakes/ sea, like the thousands of poor fishermen communities we have all over Indonesia. Not only are these the most challenging locations technically (what to built above water: fishponds? floating septic tanks, piping systems?), but also to get people to accept and use it, because there is nothing easier for them than a small hole in their floorboards and straight down… Another point coming up more frequently in Indonesia is related to balancing water quality standards, coverage and space in densely populated poor urban slum. The coverage of even basic sanitation in these areas is extremely low (as in many countries). We have built a couple good systems, which provide treatment up to / above national standards using unused space or shared with other facilities, etc… However these are expensive to built and not widely replicable (because of cost and space issues), so can only be constructed in couple communities, but often not in neighboring communities.
We are now experimenting with more simple alternatives, which require less space and are much cheaper, but do not treat to approved standards (maybe only reach 50%).
My basic question is as follows: suppose you have 4 slum areas close together, who now dispose all waste directly in nearby stream. Would it be "better" to built 1 proper facility in 1 community (with 80- 90% BOD reduction) and nothing in the other 3 (no funds or no space in the other 3 for complete system), or is it more appropriate to built 4 much simpler systems (assume 50% BOD reduction), so that at least all communities are serviced?

Response

In response to the query I have provided an overview of experience from other regions of improved sanitation for poor communities living above lakes/ sea together with an answer to the enquirers' 'basic question'.

Foort, please note that we are not sure that there is a straightforward answer to your question on whether to serve one community "properly" or whether to serve several communities to a lower, less than ideal level. From a water quality point of view both solutions may lead to a small incremental improvement (or if new settlements are appearing may slow down a decline in water quality).

If you can provide more information on the technical aspects of the two options you present then we might be able to offer a more detailed view.

Around the world there are a number of low-income settlements built along seacoasts, estuaries, mangrove swamps, lakeshores, riverbeds and in some cases these extend into the surface water itself. For urban areas, low-lying and flood prone areas are cheap alternatives for settlement sites. For rural regions, livelihoods such as fishing require settling on seacoasts or on the sea itself.

The closer a household is to the surface water, there are fewer options for excreta disposal.

The approach to improve sanitation conditions in coastal and waterfront communities and those in low-lying areas may involve more than one option or a combination of two or more systems.

Table 1: Options for improved sanitation in coastal and waterfront communities

Zone	***Options***
Dry/elevated	A pour flush toilet with a septic tank under the house for sewage treatment Pit latrines Compost latrines Cesspools Septic Tanks
Transition (e.g. tidal area)	Cesspools Small bore system Shallow bore system Septic Tanks *Or where ground water level is too high:-* Small bore sewer system and the shallow sewer system Overhung toilets – with disposal into the water or mudflat
Water	Overhung toilets with the waste directly disposed of into the water/ mud flat Bucket latrine Communal toilets

The most common solutions:

1. **Overhung latrines** are a popular solution but can pose a significant health risk to communities that use the land or water onto which the excreta falls. However, they may be the

only possible form of sanitation for people living on land that is continuously or seasonally covered with water. Overhung latrines might be acceptable provided the following conditions are met.

- The receiving water is of sufficient salinity all year round to prevent human consumption.
- The latrine is installed over water that is sufficiently deep to ensure that the bed is never exposed during low tide or the dry season.
- Floating solids are carried away from the village.
- The walkways, piers, squatting openings, and superstructures are made structurally safe for adults and children.
- The excreta is not deposited in still water or into water that will be used for recreation.

2. Economically and technically, **the provision of communal toilets built on more stable land appears to be the most feasible option**. However, it is important to consider the social and cultural limitations of this option as well as the maintenance and operation requirements. There are instances where people prefer to use their individual overhung latrines or defecate on the surface waters than to use dirty communal toilets.

Table 2: Examples of sanitation systems used by other communities living near water

	Examples of other communities on the coast or large rivers	Description of the technology	Advantages	Problems encountered
Communal toilets	• In Port Moresby, Papua New Guinea, six communal toilets were built on the mainland for the Koki squatter settlement, which is built entirely on the sea. •Public toilets were built under the Kampung Improvement Program for the *kampung* settlements located at swamp and marshy lands in Jakarta • In Klong Khum in Bangkok, Thailand, public toilets were provided by the National Housing Authority of Bangkok	Communal toilets or public toilets consist of a number of cubicles built on more stable grounds shared by community members	This is the most common approach used to solve sanitation problems in coastal communities	• In the Koki settlement, the communal latrine did not function well, so people continued to use the sea for sanitation. • In Jakarta, the public toilets built were not used much and did not function properly because the collection tanks of the facility were flooded whenever it rained. Since users had to pay to use the facility, many children defecated over open drains instead • The residents of Klong Khum preferred to have latrines inside their houses, rather than use communal facilities which were at some distance from their homes. • In general, usage not a success due to limited capacity, very poor access to users and poor maintenance. Hence, individual toilets were informally built by the people.
Cesspools	•Cesspool used in the *klong* or canal settlements in Bangkok, Thailand. Wastewater from sullage cesspools and surface run-off are directed into the pond or stagnant water beneath the house	The cesspool consists of concrete rings which are about 0.75 meter in diameter with small holes through the rings. The rings are stacked below the latrine floor and fixed above it is a ceramic toilet bowl with or without a water trap. The floor of the latrine is generally raised above the floor level to avoid overflow during the rains	• Widely accepted by the residents in Bangkok because of its ease of construction and low cost • Designed for areas with a high ground water level • Available in prefabricated form and construction at the site takes only a few hours, and no special skills are required	• Regular collection of sludge is required • Designed for areas with high groundwater level, pollution problems still occur due to poor implementation and usage of the system
Septic Tanks	•Communities in the small islands of the South Pacific used pour-flush toilets linked with septic tanks were used • Kiaracondong district - large slum near center of Bandung	A sealed tank having both an inlet and an outlet into which excreta are flushed from a conventional cistern flush toilet or a pour-flush toilet	Sewage treatment	• This option require at least yard or household pump to function • In Jakarta, septic tanks used in flood-prone areas or areas with high ground water levels do not function well due to poor soil conditions (low-permeability is a

	city, Indonesia as well as slums in Jakarta also used septic tanks			problem for the subsurface effluent disposal system), which means that much of the sewage from the septic tanks goes untreated into canals and swamps.. • The use of salt water to flush latrines retards decomposition and soakaway of sewage, hence making the system operate ineffectively • Suitable disposal for sludge withdrawn from septic tank was dumped into river. • Waste could be emptied manually or removed by a vacuum suction tanker or carts
Composting toilets	In swampy and flood-prone areas of Vietnam, the Vietnamese composting toilets are used and are considered to function well in such ground conditions. Also be trialed in Indonesia	A compost toilet is a dry or waterless toilet, that allows natural processes to produce useful compost, after a resting period depending on the type of toilet. There are usually two chambers – one in use and one resting.	Saves water, provides compost	• Water infiltration into the vault must be prevented; • Wastehandling and a high degree of user care and attention are required
Bucket latrines	The bucket latrine is used in coastal communities located on the plain of the lower Yangtze, on the eastern coast of China	Improvements to the normal bucket latrine system by providing facilities for washing and disinfecting the buckets and by covering collection buckets with tightly fitting lids.	Cheapest method for excreta collection in terms of capital investment; it is highly flexible and does not require any major capital outlay by the householder	• The use of water for anal cleaning • Social and cultural acceptance of waste handling is the main limiting factor for other cultures
Small bore sewer system and the shallow sewer system	In the Koki settlements in Port Moresby, Papua New Guinea, a sewerage system was provided as part of the master plan of the community.	Use of the shallow sewer system in the water zone with the small bore sewer applied in the transition and dry zones	Feasible options in coastal communities. The small diameter sewer lines can be laid down on shallow trenches and can extend underneath the walkways above the water. With this option, low-volume pour-flush toilets (in areas where the water supply is standpipe level of service) can be built above the water with the small diameter sewer collecting the waste. The sewer lines can then be connected to the main sewer, if available, or to a communal septic tank built on more favorable ground for waste treatment. The small bore system, on the other hand, can upgrade the existing septic tanks and make them function properly, by connecting the tanks with small diameter sewer lines. The system requires no manual handling of waste and allows the use of water for toilet hygiene	• High cost and the high water service level required
Pit latrine		Pit latrines, are the simplest and cheapest		• Prevention of contamination of nearby

		type, minimally defined as a hole in the ground. The most basic improvement is installation of a floor plate. Double pit and raised pit and lined latrines in the case of high groundwater level.		water supplies and their application only in low-density settlements
Overhung latrines	• Guayaquil, Ecuador, squatter communities are built over tidal swamplands • Jakarta: kampungs along the river, as well as the coastal marshlands in the northern periphery of the city. Most people use latrines, with outlets to or built directly into swamps and canals • Harcourt metropolis, Nigeria waterfront squatter housing areas • the Old City, Dhaka Bangladesh • Port Moresby, Papua New Guinea, Koki squatter settlements are built mainly over the sea.	The overhung latrine is commonly used above the tidal flat, river, canal, lake or swamplands problems are associated with a contaminated water supply and a lack of sanitation facilities, specifically, toilets with proper waste treatment	The disposal of untreated human waste into water or tidal mudflats, is practiced in most coastal and waterfront communities. It is satisfactory from the public health point of view, if the water is saline enough to prevent its use for drinking, if the faeces are always deposited into the waters and not on land, and if there is sufficient current for dilution.	• Bangladesh committed itself to achieving 100% ('total') sanitation coverage by 2010.Recent surveys have shown a significant move away from 'open defecation' and the use of 'hanging latrines'.

Response to basic question

Basic question is as follows: suppose you have 4 slum areas close together, who now dispose all waste directly in nearby stream. Would it be "better" to built 1 proper facility in 1 community (with 80- 90% BOD reduction) and nothing in other 3 (no funds or no space in other 3 for complete system) , or is it more appropriate to built 4 much simpler systems (assume 50% BOD reduction), so that at least all communities are serviced?

Estimate

BOD values of 4-800mg/l are common in cities and towns in developing countries.

Where raw sewage contains approximately 40g of BOD/person, if a community is using 100l/person.day, its sewage contains 40 x 10^3/100 = 400mg/l of BOD

Option A: 1 community (with 80- 90% BOD reduction) and nothing in other 3
Average to BOD reduction for the 4 slums: 90% BOD reduction/4 slums = an average of 22.5 % reduction.
With a BOD value of 400mg/l, 22.5% reduction = 90mg/l.
Meaning that after treatment the effluent discharged has a BOD value of 310mg/l

Option B: 4 much simpler systems (assume 50% BOD reduction)
Average to BOD reduction for the 4 slums: 50% BOD reduction x 4/ 4 slums = an average of 50 % reduction.
With a BOD value of 400mg/l, 50% reduction = 200mg/l.
Meaning that after treatment the effluent discharged has a BOD value of 200mg/l

According to this estimate Option B appears to offer the best option for BOD removal. Nevertheless, typical discharge standards for BOD range from 20mg/l – 30mg/l

However, the most appropriate technology is considered as that which provides the most socially and environmentally acceptable level of service at the most economic cost. Other considerations for facility construction in low-income communities located on coastal, waterfront and low-lying areas include:

Table 3: Other considerations when siting a sewage treatment facility

Health	• Transition areas where human waste is directly disposed into the ground underneath the house and excreta accumulate; • Usage of water for domestic and personal washing which is disposed of directly into the ground and surface water; • Hygiene education needed to support the chosen option; • Material used for anal cleaning
Community relations	• Potential to harm relations between slum communities (preferential treatment?);
Socio-cultural	• Demand for the treatment facility; • Demand for sanitation / latrine usage • Cultural values - technologies involving re-use of excreta; attitude to waste handling i.e. bucket latrines; prefer water for toilet hygiene; attitude in sharing toilet facilities

	• Privacy requirements for communal toilet facilities
Location	• Distance to surface water; • Community located in the dry, elevated and transition zones • Houses built above the deeper waters -sufficient water for dilution?; Excreta disposed of into the stagnant waters or on the ground underneath the built toilet • Accessibility • Convenience of users
Financial	• Less capital-intensive • Cost of construction - residents are hesitant to invest their money in toilet facilities when they do not own the land they are occupying; • Other complementary investments
Technology	• Target number of users • Physical conditions; • Location of the house • Types of toilet built
Environmental	• Water supply service levels • Soil condition requirements (soil permeability and stability) • Housing density / population density • Reuse potentials • Drainage • Ground water level • Topography of the site
Millennium Development Goals	• Simpler technology may result in 100% coverage of improved sanitation
Legal	• A simpler system might not meet required standards, therefore it could be better to install the higher standard system in 1 community

References

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Record of search

Search strategy	Search tool
Search Engines	**Google, Yahoo!**, and **Dogpile**
Water and Sanitation Portals or Subject Gateways	**Development Gateway - Water Resources Management:** http://topics.developmentgateway.org/water **ID21 Research Reporting Service:** http://www.id21.org/ **IRC International Water and Sanitation Centre:** http://www.irc.nl **The Water Page:** http://www.thewaterpage.com **WatsanWeb:** http://www.skat.ch/watsanweb/
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Fact sheets, technical briefs, and thematic overviews	**GATE watsan technical briefs:** http://www.gate-international.org/publications.htm **IRC Thematic Overview Papers (TOPs):** http://www.irc.nl/content/view/full/3271 **IRC FAQ sheets:** http://www.irc.nl/content/view/full/8027 **ITDG Technical Briefs:** http://www.itdg.org/index.html?html/technical_enquiries/technical_briefs.htm~mainFrame **Lenntech Water FAQ Frequently Asked Questions:** http://www.lenntech.com/Water-FAQ.htm **LifeWater technical bulletins:** http://www.lifewater.org/resources/tech_library.html **One World Water and Sanitation Topic Guide:** http://www.oneworld.net **WaterAid Technology Notes:** http://www.wateraid.org.uk/international/what_we_do/how_we_work/sustainable_technologies/technology_notes/default.asp **WEDC Technical Notes for Emergencies** http://wedc.lboro.ac.uk/who_Technical_notes_for_emergencies/ **WELL Fact Sheets:** http://www.lboro.ac.uk/well/resources/fact-sheets/fact-sheets.htm **WELL Technical Briefs:** http://www.lboro.ac.uk/well/resources/technical-briefs/technical-briefs.htm **WHO water-related diseases fact sheets:** http://www.who.int/water_sanitation_health/diseases/diseasefact/en/ http://www.who.int/water_sanitation_health/hygiene/emergencies/envsanfactsheets/en/index2.html **A Guide to the Development of on-Site Sanitation**: http://www.who.int/docstore/water_sanitation_health/onsitesan/begin.htm **Appropedia**: http://www.appropedia.org/Welcome_to_Appropedia **Howtopedia:** http://www.nrsp.org.uk/index.aspx **Hygiene Evaluation Procedures: Approaches and Methods for Assessing Water - and Sanitation**:

	http://www.unu.edu/unupress/food2/UIN11E/UIN11E00.HTM#Contents **WELL Technical Briefs**: http://www.lboro.ac.uk/well/resources/technical-briefs/technical-briefs.htm **OXFAM: Emergency manuals and guidelines*:*** http://www.oxfam.org.uk/resources/papers/emergency.html **C@TAS Appropriate & Alternative Technology**: http://www.catas1.org/eng/home.htm
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Water Research Institutes	**Centre for Affordable Water and Sanitation Technology** (CAWST) http://www.cawst.org/index.php?id=23 **CRC for Water Quality and Treatment** (Australia)**:** www.waterquality.crc.org.au **Development Technology Unit (DTU):** http://www.eng.warwick.ac.uk/DTU/ **DVGW - Water Technology Center TZW** (Germany)**:** www.tzw.de **Imperial College, Environmental and Water Resource Engineering (EWRE):** http://ewre-www.cv.ic.ac.uk/ **Foundation for Water Research (FWR):** http://www.fwr.org/ **Institute of Water and Environment:** http://www.cranfield.ac.uk/sas/ **International Water and Sanitation Centre (IRC):** www.irc.nl **International Water Association**: www.iwahq.org.uk **Practical Action:** http://www.practicalaction.org **Surrey University, Centre for Environmental Health and Engineering**: www.surrey.ac.uk/CEHE **Swiss Centre for Development Cooperation in Technology and Management (SKAT):** http://www.skat.ch **The STOWA (Foundation for Applied Water Management Research):** www.stowa.nl **Water and Environmental Engineering Group:** http://www.engineering.leeds.ac.uk/civil/ **Water and Environmental Health at London and Loughborough (WELL):** http://www.lboro.ac.uk/well/index.htm **Water and Sanitation for Developing Countries (SANDEC):** http://www.sandec.ch/ **Water Environment Research Foundation** (US)**:** http://www.werf.org//AM/Template.cfm?Section=Home **Water, Engineering and Development Centre (WEDC):** www.lboro.ac.uk/wedc **EAPRO: Resources on water, sanitation and hygiene**: http://www.unicef.org/eapro/activities_3582.html **OASIS Resource Centre**: http://www.oasis-water.net/html/welcome.html