EXPERIENCES OF ON-SITE WASTEWATER TREATMENT IN INDONESIA.

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Abstract

The lower capital cost and decreased disturbance when installing on-site treatment systems, compared to extensive sewerage systems makes on-site treatment a more viable form of sewage treatment for developing countries. However there are still problems associated with implementing sustainable on-site wastewater treatment systems in developing countries. This paper highlights some of those problems and offers some solutions.

A demonstration project, involving the installation of two on-site wastewater treatment systems in Indonesia, was studied. Problems encountered during installation of the systems are discussed along with possible solutions. Other on-site wastewater treatment systems in Indonesia were also studied. By collating the knowledge gained from these studies a number of guidelines have been developed that should be addressed, in order to make on-site wastewater treatment systems work in developing countries. These guidelines are -

(i) A simple system has more chance of working.
(ii) Materials should be obtainable locally.
(iii) Systems need to be designed specifically for the situation, no one system taken 'off the shelf' will work in every situation.
(iv) The greater the extent of local involvement in planning and installation of an on-site system the more likely it is to be successful and sustainable.
(v) Allowances for ongoing operation and maintenance costs need to be integrated in the project.
(vi) Indigenous technologies and local innovations should be taken into account when designing systems.
(vii) Reuse of treated wastewater and faeces should be a major consideration in designing and selecting treatment technologies.

Keywords

community participation, developing countries; domestic wastewater treatment; indigenous technologies; local knowledge; project guidelines.

1 Introduction

Only 51% of Indonesian people have sanitation facilities (WHO 1996). Most urban households either treat their waste with septic tanks or dispose of sewage and other wastewater directly into rivers and canals (Suriptono 1998). Septic tanks in Indonesia only treat toilet water (blackwater); the remaining wastewater (greywater) flows directly into open drains (Tjaturono *et al*. 1998)

Domestic waste in Jakarta contributes 79% of total wastewater and 73% of the Biochemical Oxygen Demand (BOD) load of total wastewater. BOD generated by commercial and industrial activities contributes 12% and 15% respectively to the total BOD of wastewater (Japan International Co-operation Agency - JICA 1991). Septic tank discharges are polluting the ground water of Indonesia through contamination by nitrates and organic compounds increasing BOD levels (World Bank 1994: 69-70). As well as the environmental problems caused by these loads to water resources, there are also negative health ramifications for residents, considering groundwater is the main source of domestic potable water in most cities of Indonesia (Tjaturono *et al.* 1998). Within the Brantas basin, East Java there has been a marked increase in typhoid cases. It is likely that this is due to domestic wastewater pollution in the Brantas River and the utilisation of the river by the riverbank communities for bathing (Koffel 1998). Alternative methods of treatment and reuse of wastewater are needed to minimise environmental impact and pathogen hazard.

It was with this in mind that a demonstration sanitation project was proposed by the Remote Area Developments Group of Murdoch University. The project was funded by AusAID and administered through the Pollution Control Implementation Project (PCI) based in Surabaya. Murdoch University worked on the project with their partner University in Malang, Universitas Merdeka. The site chosen was a high-density squatters' community on the edge of the Brantas River in Malang, East Java. Although there are a few toilets in the community the vast majority of people rely on the river as their sole ablution facility. The project involved installing two ablution blocks with accompanying wastewater treatment systems; each designed to serve 50 people. The first system to be installed was an aerobic treatment system, while the second system was a combined soil infiltration and evapo-transpiration system.

The problems associated with this project, coupled with a study of locally instigated sewage treatment projects, highlight a number of issues that are important in implementing successful sewage treatment projects. The UNDP-WB (1997) states that learning from the past is the main means of improving the sustainability of future sanitation projects. The lessons learnt from this study allowed a number of guidelines to be drawn up in order to ensure future projects are more successful. The development of these guidelines is the basis of this paper.

2 Installation of Wastewater Treatment Systems

2.1 The development of local links and community participation

Merdeka University in Malang was the local link for the project. Building and construction work required for the systems was contracted out to them. Giving the responsibility for this side of the work over to a local organization proved to be one of the greatest successes of the project. They understood the local government and private contractor infrastructure, so the bureaucratic and cultural differences between the two countries proved to be of little concern to the project.

During the planning stages of the project Merdeka University carried out information workshops for the community recipients of the ablution and wastewater treatment facilities. Specific workshops were carried out for the women of the community in order to ensure they had a good understanding of the project and wouldn't be disadvantaged.

Members of the recipient community were involved in the construction of the wastewater treatment units. This is extremely important to the overall success and sustainability of the project. Not only does it create an important sense of pride and ownership in the project (Garavito *et al.* 1998), but it also gives the community an understanding of how the system works. As they will be fully responsible for the ongoing operation and maintenance of the system it is important that they understand how the technology works.

Once a system was completed and ready for the community to begin using the facilities, training sessions on the operation and maintenance of each system was carried out. This was carried out when the system was completed and ready for the community to begin using the facilities. It was the responsibility of the provider of each system to carry out a training session. The idea of the training session was to ensure the community members understood how the system worked and would be capable of any operation and maintenance required. Due to the language barrier a staff member from Unmer was present to translate the training session and any questions or queries community members had.

2.2 Installation of aerobic treatment system

The aerobic treatment system installed consisted of a tank measuring 6m by 4m. The tank was subdivided into 8 chambers. The first two chambers being mainly for settlement and anaerobic decomposition, similar to a septic tank. From here the water flows into two aerobic chambers, air is delivered to these chambers 24 hours a day by a compressor. From the aerobic chambers the water flows into a clarification chamber where any sludge that has passed through is returned to the first chamber. Water is then chlorinated in the two chlorinating chambers in order to kill off any remaining pathogens and from the final chamber water flows out into the Brantas River.

The first problem encountered with this system was clearing the goods shipped from Australia off the docks. Although the days of KKN (Korupsi, Kolusi and Nepotisme) do appear to be coming to an end in Indonesia, change happens slowly and if people can see the chance to make a couple of million Rupiah then they often will. With limited time there was no option but to pay the exorbitant amount requested for clearing the goods. However it was decided that with the next system all materials should be obtained locally. This makes more sense all round, as materials obtained locally are cheaper, help the local economy and allow the system to be repaired more easily if and when things need repairing.

Upon completion of the system tank it was filled with water. It soon became clear that there were substantial leaks in the tank. This meant that it had to be emptied and repaired. This occurred a number of times before the tank finally held water. Every time the tank had to be repaired there were concerns that the equipment would be damaged, thus requiring a technician from Australia to come over and repair it. There would not be such concerns with a simpler system as the community would be able to do all the work themselves.

This system relies on a compressor pumping air through the aeration chambers 24 hours a day. 240volt power is required; this had been specified in the beginning to the contractors in Indonesia, however the message didn't get through. Power supply proved to be a big issue. Only 110volts are supplied by the government to this area, so step up was required to provide 220volts. This was only a small issue compared to the problem of who was going to pay the electricity bills.

Electricity is expensive in Indonesia, especially for low-income communities. The community couldn't afford to pay for the 24hour operation of a compressor. Therefore it was decided to buy a timer for the system, so that it would operate for two hours on two hours off etc. It is still doubtful whether the community will be able to afford this and so the system may be running on something more like two hours on and 22 hours off. This will obviously effect the performance of the system. A system with such high electricity reliance is not appropriate for this application and highlights the need for studying the situation into which a system will be placed before considering installing a system. There was also no planning in the project for ongoing operation and maintenance costs. No one in the community was given responsibility for operating and maintaining the system and no committee has been formed. There is no system in place for the community to contribute to the operation and maintenance costs.

2.3 Installation of soil infiltration, evapo-transpiration system

This system consists of a septic tank, built to accommodate the expected load on the system. From the septic tank the water is pumped to a bed of soil where infiltration takes place. Amended soil with nutrient removing properties is often used. In this case locally acquired black volcanic sand was used, after it was found to have nitrogen and phosphorus removing properties. The system is then planted with grass or other plant cover, and thus uses evapo-transpiration as well as soil infiltration. Water is collected after passing through the amended soil bed and can then either be reused for growing plants or can pass directly to the Brantas River.

A pump was required in this situation due to the lack of space requiring that the soil beds be placed higher than the septic tank. In a different location, ideally the soil infiltration bed would be significantly lower than the septic tank and gravity could be relied on rather than a pump for transporting the waste from the septic tank top the soil beds.

The building of the septic tank for this system was contracted out to Merdeka University, with a similar arrangement to that for the building of the holding tank for the first system. They took on the job of coordinating work and making sure the local contractors understood what was required.

Due to the valuable lessons learnt from the first system the installation of the second system proceeded a lot more smoothly. Materials were obtained locally and the system was more appropriate for the conditions, it only relied on a small amount of power for pumping water from the septic tank to the soil infiltration bed.

The installation of this system happened after the initial system had been put in. Due to a number of delays, this was a long time after the initial community information sessions. The work for the septic tank and the installation of the amended soil bed were also carried out very quickly. These factors combined meant that the community developed less of a sense of ownership and pride with the project. Other projects have shown that this is very important for the success of sanitation projects in developing countries (Garavito *et al.* 1998; Ockelford & Reed 1998; Sanda & Oya 1998).

3 Study of Other On-site Wastewater Treatment Systems in Indonesia.

Several different on-site disposal systems were studied. One of the most interesting examples of an on-site wastewater treatment system found in this study was located in Malang, the same city of the sanitation demonstration project. This system was instigated by Pak Agus, a local resident who saw members of his community getting sick from their sanitation practices of using the river as a toilet. He pulled the community together and with no outside funding they built a simple piped sewerage network from the houses to a treatment facility at the bottom of the steeply sloped kampung. The treatment system is composed of a septic tank followed by a series of five settlement ponds. The first ponds are planted with local aquatic plants and the final pond is stocked with "Ikan Lele", the local catfish. The system is relatively high maintenance, requiring desludging every three months. However this is worked into the social structure. A caretaker is paid a nominal sum of money, out of the Rp. 750 (AUD$0.15) paid each month by each household. To supplement this income, the caretaker also gets any proceeds from the sale of dried sludge for compost and catfish harvested from the system.

This system has now been replicated in other kampungs in Malang and the instigator; Pak Agus is now employed by Dinas kebersihan, the city council department that deals with sanitation. There has been no reliable testing of the effluent quality from the system. However the UNDP-World Bank Water and Sanitation Program are now carrying out a comprehensive study of the system, including tests on the effluent quality.

A non-government organisation "Yayasan, Dian Desa" in Yogyakarta, have a number of sanitation projects underway. An upflow anaerobic sludge blanket (UASB) system has been installed in Yogyakarta treating the sewage from a small community. A number of large communal septic tanks have also been installed in communities to treat all the sewage collectively. The UASB system has been less successful. This is mainly attributed to the fact that the community were told they would be responsible for building the system, but then the government wanted the system put in quickly so brought in outside contractors. The community now views the system with skepticism and has lost their feeling of ownership.

"Bia Hula" is a non-government organization concerned with sanitation in East Timor. They are currently involved in installing dual pit toilets at houses in rural areas of East Timor. They encourage the recipients to be involved in the building and installation of their systems. The cost to the recipient is greatly reduced if they do the work themselves. The sense of pride and ownership is very evident at most of these sites. The toilet and area around them is kept very clean and tidy. At one house the woman living there had a book for people to sign who came to view the toilet.

Such a simple system as the dual pit toilet has a great chance of sustainability. Any problems can be easily rectified. By involving the owners in the building of the system they develop a sense of pride and thus want to keep the system maintained. The main problem with such a system is the possibility of groundwater contamination. The toilets are always located away from wells, however their application is limited to rural areas, they are not suitable for the city. Many of the 'mandi's' (bathroom/toilet) had the water from washing directed out through a hole in the building onto crops growing nearby. This simple yet effective reuse of greywater demonstrates appropriate technology for a dry and economically poor region. The disappointing feature of the dual pit toilet is the waste of the valuable fertiliser resource that properly treated faeces can provide. In East Timor human faeces is often used as a fertiliser for growing vegetables, however the lack of treatment before it is used means that the risk of transmitting cholera and other diseases/pathogens is high.

4 Findings and Experiences

Howard (1997) argues that the first step in providing sanitation systems to developing countries should be a national diagnostic study, outlining the current sanitation status, problems and areas of greatest need. The importance of obtaining such information before instigating on-site projects cannot be over emphasized. One important aspect of this study should be to identify local government departments and non-government organizations working in the area of sanitation. By working with these groups and utilizing their local knowledge the likelihood of implementing a successful project is greatly increased. Working with Merdeka University in this project meant that they were able to deal with all government officials and the bureaucratic requirements. It also allowed better transfer of information to the recipients of the system. Merdeka University ran information sessions for the community but they also provided interpreters for the training sessions. However the overall community participation in the project was limited.

The sessions carried out with the community were only information sessions and they didn't give the community a chance to be actively involved in the planning of the project. It is likely that many of the problems associated with the installation of the aerobic treatment system could have been avoided if the local community was more involved in the planning stages. Garavito *et al*. (1998) note the importance of the community playing a major role in the choice of technology used. In the Malang project the community had no say in what technologies were used. If they had been informed of technologies available and given a choice, it is doubtful that they would have chosen the aerobic treatment system, due to its high power (and thus cost) requirement.

The project designed by Pak Agus in Malang shows how even a high maintenance system can be kept operating if the operation and maintenance costs are worked into the project at the outset. The initial system installed by Pak Agus has now been running since 1987, and is still functioning as it was initially intended. With no allowances for operation and maintenance costs in the demonstration project in Malang it is likely that this will effect the long-term sustainability of the project. A recent report by the Asian Development Bank (1999) highlights this point; "Systems that are imposed on the community, which is then expected to pay the ongoing operation and maintenance costs, usually fail".

The inappropriateness of the aerobic treatment system for the squatters community demonstrates the problems associated with placing a technology designed for Australian conditions in a developing country situation. It is possible that this system could be used for treating the sewage from a hospital or some other institution with more funding, but it will never work in a low-income community situation. Simpler systems have a far greater chance of being sustainable.

The importance of using local knowledge and indigenous knowledge in farming systems has been well documented (Chambers *et al.* 1989; Haverkort *et al.* 1991 and Millar *et al.* 1996). The same process should be carried out for wastewater treatment in developing countries. In order to provide appropriate and effective on-site systems a study of on-site sanitation systems already operating in the country should be carried out before instigating projects. As was the case in Malang, there may be local innovations that are likely to be far more appropriate for the local conditions than a technology transferred from overseas. It may be that adaptations need to be made to the local systems in order to improve efficiency and effectiveness, this is where money should be directed.

Landsell (1996) in his work in Venezuela found "that it was important to avoid the technological dependence on imported spare parts". The costs and time delays associated with the initial acquirement of goods for the aerobic treatment system highlight the problems associated with importing parts and equipment. Communities in developing countries are unlikely to have the funds to purchase equipment from overseas, so if a part needs replacing it is likely that the whole system will be left in a state of disrepair.

In developing countries sewage and wastewater are still often viewed as a commodity. This is a positive approach to be encouraged and a driver for on-site disposal In northern India composted sewage is often applied to crops as a fertiliser, or in more densely populated areas it may be anaerobically digested and the methane generated used as a fuel. Unfortunately in developed countries sewage and wastewater are more commonly viewed as a problem, with a variety of technologies being used to break down organic matter and remove nitrogen and phosphorus from the effluent.

On-site treatment, as opposed to end-of-pipe technology makes the beneficial reuse of sewerage and wastewater more viable. Using high nutrient greywater on crops as is done in East Timor by simply redirecting the bathroom water, reduces the need for expensive and often environmentally damaging fertilisers. The treatment system designed by Pak Agus in Malang, highlights the benefits that can be obtained from a well-designed treatment system. Dried sludge is sold as compost and fish are farmed in the final stages of the treatment system. It would be a shame if these simple yet effective treatment systems were lost in favour of technologies from the 'developed' world.

5 Guidelines and Strategies

By drawing on the lessons learnt from this study a number of guidelines have been set out that should be addressed before instigating on-site wastewater treatment projects in developing countries. These guidelines are relevant, not only to the situation in Indonesia and developing countries in general, but can also be applied to developed countries.

(i) The greater the extent of local involvement in planning and installation of an on-site system the more likely it is to be successful and sustainable.
(ii) Allowances for ongoing operation and maintenance costs need to be integrated in the project.
(iii) Systems need to be designed specifically for the situation, no one system taken 'off the shelf' will work in every situation.
(iv) A simple system has more chance of working.
(v) Indigenous technologies and local innovations should be taken into account when designing systems.
(vi) Materials should be obtainable locally.
(vii) Reuse of treated wastewater and faeces should be a major part of designing and selecting treatment technologies.

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