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METHODS AND TECHNIQUES OF WASTE WATER MANAGEMENT

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Abstract

This paper deals with methods and techniques of waste water management. It outlines the importance of decentralized approaches to waste water management and options for decentralization waste water treatment. This paper makes a special note on anaerobic treatment of waste water, waste stabilization ponds and constructed wet lands. This paper highlights the constraints in waste water management. This paper concludes with some interesting findings along with appropriate policy suggestions.

Keywords: **Quality, Improvement, Management, Sustainability, Treatment, Wastewater**

Introduction

As per the report by United Nations (2001) urbanization is one of the most important demographic trends of the twenty-first century, and growth is particularly rapid in lower-income countries. The majority of urban growth is associated with the rapid expansion of smaller urban centres and peri-urban developments. As per the report by United Nations (1999), much of this growth is unplanned and informal, with community members and informal-sector developers taking advantage of the fact that the regulatory capacity of government authorities is weak, particularly in those areas that are outside official municipal boundaries.

Peri-urban areas are characterized by a mixture of land uses associated with a range of urban and rural livelihoods. Settlements are generally inhabited by communities of different economic status relating to land prices, which are affected by location in relation to the city, and which are considerably higher than in rural areas. Many industries locate on the edge of the city because land there is relatively cheap and not subject to stringent development controls and, at present, the wastes they produce rarely receive adequate treatment. Due to ongoing development, peri-urban areas are generally in a state of rapid transition that may result in social and environmental tensions.

The limited infrastructure facilities that are provided are often inadequate, and the result is a poor and often deteriorating environment. Provision of infrastructure and services tends to occur in a piecemeal fashion, either through the efforts of residents themselves or as a result of pressure from civil society on elected representatives and government officials. Electricity and water supply are usually provided first, with sanitation, drainage and solid-waste collection services following later. However, the majority of settlements in per-urban areas, particularly those inhabited by poorer communities, do not have access to adequate water supply and sanitation facilities. Even where household sanitation and localized drainage facilities do exist, often there is a lack of a comprehensive system for the collection and disposal of wastewater. Wastewater production, disposal and re-use in per urban areas In per-urban areas, increasing populations, combined with increasing water consumption and a proliferation of waterborne sanitation, create widespread wastewater disposal problems. In many cases, wastewater is discharged locally into open ground and vacant plots, creating ponds of foul-smelling stagnant water. Children and others may come into contact with polluted water, especially as they often play in open areas where wastewater and refuse collects. Health risks are increased by the fact that household and surface water drainage systems are invariably combined, so that floodwater becomes contaminated with excreta. Birley, Martin and Karen Lock (1999 reported that mosquitoes and other pests breed in blocked drains and ponds, spreading diseases such as filariasis. This is a particular problem where piped water is provided before drainage infrastructure.

The lack of infrastructure and services and effective systems for managing wastewater has led to widespread pollution of surface water and groundwater and deterioration in environmental health conditions. According to Barley, Martin and Karen Lock (1998) the range of environmental health problems in per-urban areas includes those associated with both urban and rural living and, as a result, the per urban poor "…get the worst of both worlds.".The greatest impacts are upon the health and livelihoods of poor communities, who often inhabit lowlying and marginal land, for instance wetlands and alongside drainage channels, which are polluted with excreta and other wastewater. At the same time, increasing competition for limited water resources has resulted in a tendency for farming communities in peri-urban areas to use untreated wastewater for irrigation and aquaculture. Farmers often find it cheaper to exploit wastewater than to incur capital and recurring costs in pumping groundwater to irrigate crops. The re-use of wastewater for irrigation is likely to be most prevalent in regions where water from other sources is scarce for part or all of the year.

Decentralized Approaches to Wastewater Management

In response to the deficiencies of centralized approaches to service delivery, in recent years there has been increasing emphasis on the potential benefits of adopting decentralized approaches to sanitation and wastewater management, which are considered to be particularly appropriate for peri-urban areas. According to the Environmental Protection Agency, in the United States, decentralized wastewater systems may provide a cost-effective and long-term option for meeting public health and water quality goals, particularly in less densely populated areas. Broadly speaking, the implications of decentralization on wastewater management systems relate to planning and decision-making, design of physical infrastructure, and management arrangements for operations and maintenance. According to Guillermo Yepes (2001) decentralization is also seen as a way of strengthening the role of local government and democracy in general, and as an effective means of addressing environmental and health concerns. The basic tenet is that local control, as opposed to centralized control, will result in more accountable service providers and better services.

It is arguable that decentralized systems are more compatible with decentralized approaches to urban management than centralized systems. They are also compatible with the "unbundled" approach to service provision promoted by the World Bank. The Bank focuses on the financial aspects of unbundling, seeing it as a way of introducing private-sector investment and competition into service delivery and thus improving operational efficiency. However, the concept of unbundling can also cover the utilization of local resources through community-based and nongovernmental initiatives.

There has also been an increased emphasis on a more holistic approach to waste disposal that stresses the benefits of reducing the strength or quantity of waste at source and, where possible, recycling or re-using it close to the point where it is produced. Roland Schertenleib (1999) incorporates these different aspects is the household-centered environmental sanitation approach, which starts from the assumption that sanitation problems, including wastewater disposal, should be solved as close to their source as possible, with decisions and the responsibility for implementing them flowing from the household to the community to the city and, finally, to higher levels of government.

It could be noted that decentralized systems have yet to be widely accepted and implemented in practice; they do appear to offer a number of potential advantages. These relate to opportunities for greater stakeholder involvement in decision-making and planning, to financial advantages, and to the benefits of segregation of wastewater at source and compatibility with local demands for wastewater re-use. a. Decentralized decision-making and participatory planning Decentralized planning and decision-making in wastewater management offers potential benefits relating to increased responsiveness to local demands and needs and, hence, increased willingness of communities to pay for improved services.

Increased stakeholder involvement at the local level is often promoted by the non-governmental organizations (NGOs), which encourage a demand-responsive and participatory approach and often act as intermediaries to improve the flow of communication and broker agreements between communities and local government authorities. It is evident from the work of Chagall, Charles (1997) that NGOs can play a key role in assisting communities to develop their basic services, but it must also be recognized that NGOs, and indeed community involvement as a whole, do not offer a panacea to the deficiencies of the public sector. In particular, NGOs may lack the technical know-how required to plan and design effective decentralized schemes, whilst community organizations will not automatically provide the stability and reliability required to provide long-term management of those schemes. Financial advantages of decentralized management. The capital investment for decentralized wastewater systems is generally less than for centralized systems in per-urban areas, and they are also likely to be cheaper to construct and operate. By tackling wastewater problems close to source, the large capital investment of trunk sewers and pumping costs associated with centralized systems can be reduced, thus increasing the affordability of wastewater management systems. Decentralized approaches to faucal sludge collection and disposal are particularly appropriate for per-urban areas, as they reduce haulage distances and thus reduce the cost of transportation. In some cases, the investment may require little more than improvements to existing informal wastewater collection systems and the introduction of an appropriate form of treatment prior to disposal or re-use. The economies of scale mean that decentralized treatment facilities will tend to have a higher cost per person served than centralized facilities, the incremental increase in per capita cost is likely to be fairly small where unsophisticated technologies are used. Segregation of wastewater at source Domestic wastewater consists of “black” water, the mixture of water and faces flushed from WCs and pour-flush toilets, and “grey” water, the sullage from kitchens and bathrooms. Grey water contains much lower pathogen levels and has a lower oxygen demand than black water and therefore represents a much smaller health and environmental threat. Grey water and black water are produced separately, and ensuring that they remain separate can facilitate management of the two wastewater streams. This option may be considered where it is possible to dispose of black water to a leach pit or septic tank followed by a soakaway. Grey water can then be used for irrigation or discharged into a local watercourse with little or no treatment. This option creates the need periodically to remove and treat the sludge that accumulates in the leach pit or septic tank, and therefore tends to place greater demands on individual households than options that remove all wastewater from the house. However, it is arguably easier to ensure that households maintain their own facilities than to ensure effective management at the community level. Weisburd, Claudia (2000) notes that the sullage water is treated using reed beds and excreta are managed using either dry toilets with urine diversion or septic tanks. These facilities have been provided at the household level or, alternatively, as communal facilities to be managed by groups of residents. It could be known from the work of P Yekutiel (1986) that the segregation of industrial and commercial effluents from domestic wastewater at source is also an important benefit of decentralized wastewater management, in as much as wastewater from residential areas is less likely to receive highly polluted industrial flows, which is particularly important where wastewater is to be re-used, It will therefore be necessary to introduce systems for regulating and treating wastewater discharges, and local communities can be an effective means of monitoring the activities of the commercial sector.

Compatibility with local demands for wastewater re-uses

Decentralized wastewater systems are likely to be compatible with local demands for wastewater re-use in per-urban areas where water and the nutrient content in the wastewater increase agricultural productivity and contribute to the livelihoods of peri-urban communities. Wastewater may also be re-used for aquaculture, in which aquatic plant biomass is used either directly or as an ingredient in a feed-mix to raise fish or livestock for human consumption. Wastewater re-use can promote incentives for local people to operate and maintain local systems, and thus help to ensure long-term operation and financial sustainability. The re-use of waste can increase local agricultural productivity, resulting in increased revenue for local producers. Whilst this argument is not absolute insofar as financial benefits can be obtained equally well from the re-use of effluent from centralized facilities, it implies that decentralized management systems may achieve a better distribution of benefits and thus have the potential to be more pro-poor than centralized management.

Options for Decentralized Wastewater Treatment

In order to ensure that decentralized wastewater management systems protect against adverse impacts on health and the environment, some form of treatment will be required before effluents are discharged or re-used. The levels of treatment is dictated by the disposal or re-use option, for example, pathogen reduction is important when wastewater is re-used but less important when it is discharged into a watercourse. As per the report by Duncan Mara (2000) that the relative sophistication of conventional treatment processes presents difficulties for operation and maintenance at the local level, and these technologies are unlikely to be appropriate for local use because they require careful and skilled attendance. However, a range of alternative technologies are available which may be used for decentralized wastewater management systems, and these are briefly discussed below. Although these technologies are less dependent upon power for operation than more advanced technologies, they require increasing amounts of land, especially where wastewater is re-used. A potential constraint on localized management is therefore the limited availability of land for treatment facilities. This is particularly important in the case of simple options such as waste stabilization ponds and constructed wetlands, which require a large land area. Most land in urban and per-urban areas is privately owned or privately controlled. Land ownership can constrain the implementation of decentralized wastewater management systems due to the ineffective planning and control over informal development.

Anaerobic Treatment

Anaerobic treatment of wastewater is considered to be an appropriate form of technology for the treatment of black water and faucal sledges from household latrines, as it requires less land area and produces a well stabilized sludge in lesser quantities than aerobic treatment. Anaerobic treatment may also be cheaper than most aerobic treatment processes because the process of anaerobic digestion produces energy and is therefore not dependent upon an external power source.

The simplest form of anaerobic treatment is the simple septic tank, which both settles suspended solids and achieves some anaerobic digestion of those settled solids. In hot climates, septic tanks can remove 60 per cent or more of the organic load of “normal strength” sewage, but they achieve little in the way of pathogen reduction. Other anaerobic options include anaerobic waste stabilization ponds, anaerobic filters and upward-flow anaerobic sludge blanket reactors.

Waste Stabilization Ponds

Waste stabilization ponds include anaerobic ponds, facultative ponds that combine aerobic and anaerobic processes, and purely aerobic maturation ponds. The obvious advantage of pond systems is their simplicity. A second advantage is that their long retention time means that they are better than most treatment options at reducing pathogen levels. They can produce economic benefits in that maturation ponds provide a good environment for growing fish such as tilapia. The effluent from ponds has fairly high algae concentrations, so it is a good resource for irrigation. One of the disadvantages of waste stabilization ponds is that they require a relatively large area of land, especially when combined with waste water re-use.

Wastewater stabilization ponds may be integrated with re-uses systems for the production of plants such as duckweed and water hyacinth. These plants grow prolifically in nitrogen-rich environments, and can be harvested and composted and subsequently used to fertilize and condition agricultural soils. The removal of the plant biomass stimulates the continued growth of the plants and also contributes to the removal of nutrients from the wastewater and reduces eutrophication in receiving waters. These systems may also be combined with pisciculture (fish-farming). This technology has been implemented at the village level on a pilot scale in Bangladesh and consists essentially of duckweed, an aquatic plant grown in effluent holding ponds.

Constructed Wetlands

Constructed wetlands can provide a low-cost and appropriate technology for the treatment of domestic wastewater and faucal sludges,but will normally require pre-treatment and so can only be considered as a secondary treatment option. Like waste stabilization ponds, they are fairly good at removing pathogens, but facilities have to be designed and operated in a way that controls disease vectors, especially mosquitoes, and odors. Because of the problems with mosquitoes, it has been argued that wetlands may not be a suitable form of wastewater treatment for use in areas where malaria occurs.

Constraints in Waste Water Management

Even where policy makers accept the validity of the decentralized approach, a lack of capacity to plan, design, implement and operate decentralized systems is likely to be a severe constraint on efforts to ensure its wide adoption. Even in the United States, the Environmental Protection Agency concluded that lack of management was a major barrier to implementing decentralized systems. The management arrangements and responsibilities for operation and maintenance must be considered in relation to the capabilities of the individual householders, community groups or government departments. Therefore, where a system requires that ongoing operation and maintenance tasks are devolved to individual householders or community groups, it is essential that responsibilities are clearly explained at the outset. Planning and implementation of wastewater re-use systems at the neighborhood/user level will only take place successfully when the need for improved systems has been "internalized" by members of households and communities.

Institutional Constraints

In the majority of countries, there is a lack of suitable institutional arrangements for managing decentralized systems and a lack of a suitable policy framework that encourages a decentralized approach. As per the report by J Brakarz (1991) that there is a danger that decentralization will lead to fragmentation and a failure to address overall problems adequately. Without technical assistance and other capacity- building measures, problems of institutional capacity that existed under a centralized operation are simply passed on to the new structures. Decentralized management may be a problem in per-urban areas in which the boundaries between different communities may be very loosely drawn. Also, without a formal institutional framework within which decentralized systems can be located, efforts to introduce decentralized management are likely to continue to be fragmented and unreliable. Experiences from Malang, in Indonesia, show how efforts have been made to institutionalize an essentially decentralized approach.

Decentralization requires greater coordination between government, the private sector and civil society, and there is a need to look at the most appropriate institutional arrangements for managing decentralized wastewater systems and for monitoring and regulating those organizations that are responsible for their monitoring. One of the consequences of decentralization may be a lack of attention to pollution control, and it is therefore necessary to consider the regulation of wastewater discharges, which may prove difficult where there are many smaller decentralized systems.

Economic Constraints

Decentralized systems may reduce the cost of investment required for wastewater management, but the majority of local government agencies and departments lack the resources to invest in new infrastructure and rely on grants from higher levels of government to finance improvements in service provision. Many poor communities lack the financial resources to invest in improved infrastructure. Lack of access to credit may also be a critical factor, inhibiting communities' ability to invest in improved services. Those with a lack of secure tenancy also lack the incentive to invest in infrastructure to improve wastewater management practices. The acquisition of land for the more extensive forms of treatment that are effective in removing pathogens may prove difficult for those with limited financial resources.

Wastewater re-use is widely practiced in the informal sector but is limited to a few official schemes, and benefits are not widely recognized in the wider macro economy. In many parts of Asia, traditional farming practices involving re-use of excreta and wastewater have provided an economic incentive for implementing localized wastewater management systems, especially where other sources of water are scarce. However, economic pressures from the competitive marketing of fertilizer can constrain the re-use of excreta, particularly where cheap alternative nutrient sources in the form of inorganic fertilizer are available, which may negate the incentive for wastewater re-use. Where transportation systems have been improved, locally harvested produce has to compete with imported products.

Social Constraints

Cultural factors may influence the way in which people view the reuse of excreta in food production, and the attitudes of the public and the policy makers towards the perceived risks to public health play a role in the adoption of wastewater management systems in which wastewater is used for irrigation or aquaculture. Although informal systems for wastewater and fiscal sludge management and re-use have existed for many years, government public health authorities often oppose excreta re-use because of the health risks involved. Also, traditional excreta re-use practices are generally not recognized or accepted by government authorities and are likely to be seen by officials as being archaic and redundant, especially when alternative technologies, which require less land, exist. At the same time, the lack of government commitment to address wastewater-related problems creates a political and institutional environment that offers little incentive to manage wastewater effectively. This lack of commitment is reinforced by a lack of financial resources to develop and implement effective policies and programmers for managing wastewater

Advocacy

Due to the limited demand for improved wastewater management, the main challenge for planners and practitioners is to create informed demand for improved systems, focusing not only on health but also on the improvements in the local environment and in household finances that may be achieved through improved wastewater management. Advocacy at the political level is required and, at the community level, awareness campaigns to promote the benefits of improved wastewater management, involving extensive social communication and mobilization, are necessary. This advocacy must be based on applied research on what can and cannot be achieved by decentralized management systems. This suggests a need to document experience and encourage the implementation and monitoring of additional demonstration projects in order to stimulate a wider interest in the benefits of decentralized wastewater management.

Conclusion

It could be seen clearly from the above discussion that waste water management is very essential to overcome the health and sanitation problems. The success of waste water management depends on decentralized approach and there are some constraints in adoption of decentralized approaches in waste water management. The waste water treatment is very essential to solve the water pollution. The successful waste water treatment depends on the following policy suggestions.

Policy suggestions

There is a need to incorporate wastewater management systems within an integrated framework of water resource management and other services of water supply and solid waste management. Official design standards may not be framed in a way that supports the development of decentralized systems. There is therefore a need to develop appropriate standards to be utilized for the design and construction of decentralized wastewater systems, and also to promote realistic and acceptable standards for treatment where wastewater is re-used. The policy needs to be based upon practical experiences and realistic objectives, and should be developed in close collaboration with organizations involved with those communities that the decentralized wastewater systems are designed to serve.

Institutional Strengthening

This involves a change of focus of activities, whereby traditional centralized agencies take on a different role, focusing on the need for capacity strengthening to develop new skills to respond to the needs and demands of communities. This places greater emphasis on the role of centralized agencies as facilitating organizations, providing technical assistance and focusing on improved systems for coordinating the activities of different stakeholder groups involved in decentralized wastewater management. It also requires that these institutions develop capacities for monitoring and regulation, and effective systems for enforcing appropriate policies.

Training and Dissemination of Technical Information

The choice of technology is limited by the need to ensure that the operation and maintenance requirements of the chosen technology are compatible with the levels of knowledge and skills available at the local level. There is often a lack of knowledge of decentralized options and a shortage of qualified workforce and skills for operation and maintenance. The management requirements in terms of the local availability of skills and knowledge to operate and maintain technologies and services for wastewater and fiscal sludge management are therefore critically important. There is therefore a need to focus on the training of local stakeholders, to enable them to understand how various technologies operate, their operational and maintenance requirements, and the implications in terms of possible effluent re-use. There is also the need to disseminate technical information in appropriate forms and languages, in ways that are understandable and relevant to the needs of those who are responsible for the design and operation of decentralized wastewater and fiscal sludge collection and disposal systems.

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