Wastewater Management in Lagos State: Moving Toward a More Sustainable Approach

In Lagos State, Nigeria, water resources are being severely affected by pollution from wastewater discharges. As urban and industrial development has grown, the quantity of wastewater and sludge generated has also increased. These wastes pose a threat to public health when they are not managed properly.

Decentralized systems could improve environmental quality at an affordable cost

About This Article

This article analyzes problems related to the management and disposal of wastewater in Lagos State. The discussion reviews current management practices used in treating and disposing of wastewater. It also highlights wastewater management issues in the European Union, where interest in more sustainable wastewater management systems is growing.

As the discussion makes clear, the practice of indiscriminately dumping wastewater into waterways with little or no prior treatment needs to be given urgent attention. We offer several observations and suggestions for improvement.

Background: Water Issues in Lagos State

Lagos State

Lagos State is located in southwestern Nigeria, on the western coast of Africa. Although it is small in terms of land area, Lagos State is highly urbanized, with 70 percent of its population living in urban centers. The state includes the city of Lagos, which is Nigeria's largest urban center and one of the principal cities in Africa.

The population of Lagos State has been estimated at around 10 million. It is the commercial center of the country, with the largest concentration of industrial and business facilities. The state is home to more than 70 percent of Nigeria's industry (Iwugo, D'Arcy, & Andoh, 2003).

As urban and industrial development has increased, the quantity of waste generated has also increased. Because of issues related to wastewater

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management, the water bodies of Lagos State are experiencing high levels of pollution, and clean water is becoming a scarce resource. The problems associated with water pollution and inadequate water resources endanger the health of the populace and threaten other resources (such as fisheries and soil).

Research Aims

The research discussed here sought to assess wastewater management in Lagos State, with the aim of finding ways to minimize the problems related to wastewater disposal. As part of this research, we carried out a literature survey that focused on several key areas, including wastewater management in Lagos State; industries in Lagos State and how they treat and manage wastewater; wastewater management in other parts of the world, especially Europe; and potential alternative strategies for wastewater treatment and disposal that are more environmentally friendly, cost-effective, and affordable.

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Environmental Policy in Nigeria

National environmental policy in Nigeria is administered by the Federal Environmental Protection Agency (FEPA). As stated in its goals, this policy seeks to:

- achieve sustainable development in Nigeria;
- secure a high-quality environment for the health and well-being of the people of Nigeria;
- conserve and use the environment and natural resources for the benefit of present and future generations;
- restore, maintain, and enhance ecosystems and ecological processes, adopting the principle of optimum sustainable yield in the use of living natural resources and ecosystems;
- raise public awareness, promote understanding of essential linkages between the environment and development, and encourage individual and community participation in environmental improvement efforts; and
- cooperate in good faith with other countries, international organizations, and agencies to achieve optimal use of transboundary natural resources and effective prevention or abatement of transboundary environmental pollution.

FEPA's Lagos office and zonal laboratory complex, which was commissioned in 1990, serves as a national environmental reference laboratory and handles environmental monitoring activities.

Wastewater Management in Nigeria and Lagos State

Wastewater Management in Nigeria

Researchers have identified a number of environmental problems in Nigeria that are related to wastewater management practices (see, e.g., Adekanbi, 1979; Adenuga, Ogujiuba, & Ohuche, 2003; E. O. A. Aina, 1991; Orubu, 2006). These problems include: deterioration of coastal waters caused by sewage disposal; eutrophication in receiving water resources; issues related to production and disposal of sludge from wastewater treatment processes; flooding during storm events; severely reduced water flows in rivers and streams; and pollution and depletion of groundwater.

In Nigeria, only a small fraction of urban sewage is treated. Wealthier neighborhoods generally are connected to centralized sewer systems.

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However, poorer neighborhoods have no such facilities.

In most Nigerian cities, management of urban services (including sanitation) is handled by local government agencies. Other agencies (including federal, state, and local agencies responsible for health, water, and public works) may also participate in managing some services.

The state of wastewater management in Nigeria is generally poor, due in large part to lack of adequate funding and institutional infrastructure. Most areas cannot afford to purchase wastewater management equipment. They also lack efficient administrative organizations with clear lines of authority and qualified personnel.

Wastewater Management in Lagos State

As is the case in other parts of Nigeria, wastewater management in Lagos State is minimal, with only a fraction of wastewater being treated. Sanitation systems currently used in Lagos State include both government and private facilities. A small number of publicly owned plants are available to treat wastewater before it is released into water bodies.

The existing facilities serve only a limited part of the population. It has been estimated that about 94 percent of people in Lagos have no access to sanitary toilets (O. C. Aina, 2007; Federal Office of Statistics, 1997; United Nations Children's Fund [UNICEF], 1995).

In Lagos State, the availability of sewage facilities has not increased, even though the population has grown. As a result, there has been a decline in the percentage of the population served by sewage infrastructure. In addition, coastal tourism has increased, without accompanying growth in water and sewage facilities. These trends pose a serious threat to public health, coastal habitats, and economic development in the state (O. C. Aina, 2007; Federal Office of Statistics, 1997).

■ Commonly Used Systems

On-site disposal systems are commonly used in both urban and rural areas of Lagos State. Residents often rely on systems such as soak-away pit latrines, pit privies, pour-flush latrines, and communal toilets.

Also common are septic systems and soak-away pits. These systems typically consist of two-compartment septic tanks and seepage pits. Many household septic systems are substandard, as constructing an adequate system can be costly. It should be noted that septic systems generally are not a satisfactory choice in Lagos State, which is located in a coastal area where the water table is close to the surface (United Kingdom Environment Agency, 2006).

> The collection, treatment, and disposal of sewage and wastewater represent major environmental concerns in Lagos State.

■ Environmental Damage

The on-site systems of wastewater management commonly used in Lagos State have begun to threaten both surface and groundwater resources (Iwugo et al., 2003). The resulting water pollution creates health hazards, including the potential for epidemic disease in Lagos and the surrounding areas.

The collection, treatment, and disposal of sewage and wastewater represent major environmental concerns in Lagos State. Untreated sewage and industrial effluent typically are dumped in the Lagos lagoon. Both domestic wastewater, which contains human waste, and industrial wastewater, which contains heavy metals and other substances, cause pollution and contamination (O. C. Aina, 2007). Seepage from on-site systems is steadily increasing the level of groundwater pollution, a problem that is made worse by the high water table (Kuvaja, 2001).

The sewer infrastructure that does exist in Lagos State is badly managed. Wastewater and dissolved solids can be released when there are malfunctions in treatment plant equipment, such as pumps, sedimentation beds, and filtration beds (Egboka, Nwankor, Orajaka, & Ejiofor, 1989).

■ Past Studies and Initiatives

There have been many initiatives and studies aimed at addressing the wastewater management and water pollution problems in Lagos State. For example, a Master Plan for Metropolitan Lagos was prepared in 1979 by Wilbur Smith and Associates in collaboration with the United Nations Development Programme and the government of Lagos State (United Nations/ Wilbur Smith & Associates, 1980a, 1980b).

> Lagos State needs a wastewater management system that is sustainable and environmentally friendly. Ideally, such a system would be low-cost and would involve minimal operational and maintenance requirements.

From 1986 to the present, Lagos State government has commissioned four major drainage, wastewater treatment, and water pollution studies that were cofunded by the World Bank, the United Kingdom, and the Department of International Development.

The government also has made several attempts to provide conventional and centralized sewerage systems. However, research suggests that centralized wastewater management is socially, environmentally, and financially unsustainable for Lagos State (Hedberg, 1999). The construction of these systems is costly and unaffordable. Running them involves intensive water usage and operational problems.

■ Toward a More Sustainable System

Conventional sewerage systems are designed as waste transport systems in which water is used as the transport medium. But water resources are scarce in Lagos State, and they are being depleted and polluted at an alarming rate (Akujieze, Coker, & Oteze, 2003). Conventional systems are not appropriate for communities where water is scarce.

Moreover, conventional sewer systems dilute human waste and spread pollution over a larger environmental domain. This creates concern about the quality of wastewater that is being released into the environment.

Lagos State needs a wastewater management system that is sustainable and environmentally friendly. Ideally, such a system would be low-cost and would involve minimal operational and maintenance requirements. It would treat effluent before discharging it to water bodies. The treated effluent would meet all recommended microbiological and chemical quality guidelines (Arar, 1988).

Industrial Wastewater Management in Lagos State

Lagos State is home to much of Nigeria's industry. Factories often are located on riverbanks and use rivers for disposal of effluent. The major industries responsible for water pollution in Lagos State include petroleum, mining, pharmaceuticals, textiles, plastics, iron and steel, brewing, paint, and food. The petroleum industry represents the greatest industrial threat to water quality, due to accidental oil spillages.

Applicable Environmental Standards

In 1991, FEPA issued guidelines and standards for environmental pollution control, including interim uniform effluent limits for all categories of industry (Federal Environmental Protection Agency, 1991). The current environmental standard requires all industrial wastewater to be adequately treated before it is discharged back to the environment.

FEPA has authority to test industrial effluent characteristics to determine whether the ef-

fluent complies with applicable environmental standards. However, research shows that many industries in Nigeria do not adequately treat their raw wastewater before disposing it into the nearest watercourse (see, e.g., Oke, Okuofu, & Otun, 2006).

Several researchers, including Arundel (2000) and Yagoubi et al. (2000), have discussed the impacts of inadequate industrial wastewater treatment on nearby water bodies.

Industrial Wastewater Treatment Practices

The industrial establishments in Lagos vary in terms of size, process technologies, product types, wastewater discharge characteristics, and receiving environments. Several researchers have studied the wastewater treatment practices in individual industries.

Sangodoyin (1995) studied the disposal techniques used by a range of industries in Lagos. This research revealed several key findings:

- In the brewery industry, wastewater is pumped onto settling tanks. After being allowed to settle for a period of time, the wastewater is disposed into nearby rivers. Occasionally, effluent is sent through another device for further treatment before disposal. This additional treatment can greatly improve water quality in streams where the wastewater is disposed.
- In the paint industry, facility wastewater typically is conveyed via drains from different locations to a central point that leads to a primary effluent treatment plant. In most cases, the treatment plant consists of a sedimentation tank and a pressure filter. Caustic soda often is added to the wastewater, which is allowed to settle for a period of time in the sedimentation tank before being discharged into a local stream.
- Businesses in the food and beverage industry generally use oxidation ditches for treating

wastewater before disposing it through gullies.
- In the pulp and paper industry, treatment facilities do little more than separate the mud and liquid components of wastewater prior to disposal.

A study by Al-Mutairi, Hamoda, and Al-Ghusain (2004) found that Nigeria has no wastewater treatment plants for abattoirs. This poses a serious problem since abattoir effluent can critically impact human health, agriculture, potable water supplies, and the ecology of aquatic species. Such effluent represents a major source of water pollution. The wastewater samples that the study collected from two abattoirs in Lagos were highly contaminated. This highlighted the need to pretreat abattoir wastewater before discharging it to the environment.

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Adeoti (2005) reviewed wastewater treatment in Nigeria's textile and food and beverage sectors. Quoting from Forrest (1994), the study noted that these two sectors are among the oldest manufacturing industries in Nigeria. Adeoti's research examined a sample of 95 food and beverage companies and 27 textile firms. The study found that 59 percent of the food and beverage companies used primary industrial wastewater treatment, while 36 percent used secondary treatment, and only 3 percent used more advanced types of treatment. In the textile industry, 16 percent of the companies used primary wastewater treatment, while 42 percent used secondary treatment, and 42 percent used more advanced types of treatment.

In the textile industry, wastewater typically goes through a partial primary sedimentation

tank before being discharged into drainage systems, without any biological treatment taking place. As a result, the wastewater contains high levels of pollutants, such as desizing acids and dyeing bases (including caustic soda) that are used for scouring and mercerization. This effluent also has been found to contain high levels of chlorine, organic compounds, and enzymes (Asia, Oladoja, & Bamuza-Pemu, 2006).

Wastewater Management in the EU

A review of conditions in the European Union reveals that Europe is also experiencing a range of wastewater treatment issues. In most parts of the EU, wastewater management relies on conventional treatment systems. Such systems are expensive to construct and to manage.

According to the World Health Organization and UNICEF, over 20 million EU citizens (mostly in central and eastern Europe) lack access to safe sanitation. The locations most affected are rural areas, where residents often lack sufficient financial resources (World Health Organization/UNICEF, 2000).

EU regulations on wastewater (contained in article 3 of the Urban Waste Water Directive) require localities with a population equivalent of more than 2,000 people to have urban wastewater collection systems. The regulations specify that adequate biological treatment should be provided.

This implies that, under the EU directive, settlements with smaller populations have no binding obligation to provide biological treatment via urban wastewater systems. Such localities may rely on other systems for wastewater treatment in order to prevent pollution from reaching water-

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ways. Among the alternative approaches generating interest are decentralized sanitation systems, which are discussed in the following section.

Achieving More Sustainable Wastewater Management

Conventional sanitation systems, although common throughout much of the world, have been subject to growing criticism. Commentators note that these systems are costly to construct and operate, and that they use high volumes of water. Moreover, inhabitants of rural areas often have no access to them.

Given the social, environmental, and financial issues associated with centralized wastewater management systems (see Braden & van Ierland, 1999), some critics have argued for adoption of more localized systems. These commentators advocate the use of sustainable sanitation systems, which can offer a more environmentally and economically sound approach to sanitation.

Sustainable sanitation systems are based on the three pillars of sustainable development: environmental, economic, and social responsibility. These systems emphasize using waste as a resource. Sustainable sanitation systems aim for the complete recovery of all agricultural nutrients from waste and greywater. When properly designed, such systems can minimize water pollution and help ensure that water resources are used economically.

Within a sustainable sanitation system, wastewater should be reused to the greatest extent possible, typically for sustainable irrigation. These systems separate human waste from wastewater, which is then sanitized and reused separately for agricultural purposes (Pradhan, Nerg, Sjöblom, Holopianen, & Heinonen-Tanski, 2007). According to Heinonen-Tanski and van Wijk-Sijbesma (2005, p. 403), the amount of excreta that each individual produces annually can be used to

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fertilize 250 kilograms of cereal grains (a year's supply of cereal for one person).

Decentralized systems have already received attention in Europe and elsewhere because they can potentially decrease costs, manage waste more efficiently, reduce environmental hazards, and create opportunities for wastewater reuse (see Butler & MacCormick, 1996; Otterpohl, Grottcker, & Lange, 1997; Venhuizen, 1997a).

Decentralized sanitation systems involve managing and reusing wastewater locally (as close as practicable to the location where the waste is generated). A community's decentralized wastewater management system typically includes several smaller subsystems for collection, treatment, and reuse of wastewater.

Discussion: Improving Wastewater Management in Lagos State

A large percentage of inhabitants in Lagos State do not have access to safe and adequate basic sanitation services. Unsanitary disposal of sewage and wastewater has created problems with water pollution and soil contamination. These issues contribute to contamination of food and water supplies, which constitutes a major source of disease and infection (Ikurekong, Esin, & Udofia, 2008).

In Lagos State, the rate of preventable parasitic diseases has increased among the human population. These problems are being aggravated by environmental contamination and poor sewage and wastewater disposal practices.

The wastewater management plants in the state function at a substandard level. Wastewater management is most commonly handled by on-site disposal systems. Because the water table is close to the surface, these on-site systems have begun to threaten groundwater resources.

The applicable environmental guidelines in Nigeria require all industries to treat their effluent in-house before disposing of it in the environment. However, many industries do not conform to this guidance. Industrial facilities often fail to treat their raw wastewater adequately before discharging it. Analysis of industrial effluent streams indicates that many do not meet the relevant FEPA standards (Adeoti, 2005).

Since Lagos is a densely populated commercial center, it might seem imperative to adopt a centralized system of wastewater management. However, practical problems stand in the way of implementing such a system.

In the past, the government of Lagos State has made attempts to construct conventional, centralized wastewater management systems. These attempts have met with little success because of the high costs associated with conventional systems and their need for large volumes of water.

A better option might involve managing wastewater through a sustainable sanitation system. Such a system would separate domestic wastewater into different constituents and allow for reuse of these natural resources (in the form of nutrients, water, and heat).

> **Sustainable sanitation can help protect public health, encourage recycling of nutrients, and prevent environmental degradation.**

Sustainable sanitation can help protect public health, encourage recycling of nutrients, and prevent environmental degradation. Because contaminated wastewater is one of the main sources through which diseases are spread in most parts of the world, it is important to find a barrier that will prevent exposure to it.

Sustainable, decentralized sanitation systems are particularly attractive in communities that have limited financial resources since such systems can be constructed and operated at low cost compared to conventional sanitation systems. Decentralized systems also offer a number of

other advantages, including management efficiency, increased opportunities for reuse of resources, and less potential for serious environmental hazards when accidents occur (Butler & MacCormick, 1996; Otterpohl et al., 1997; Venhuizen, 1997b).

In the developed world, wastewater treatment approaches may depend in part on how the wastewater will be reused. If sewage wastewater is to be reused for irrigation, the main aim of treatment will be to eliminate pathogens. The nutrients in the wastewater can then be used to fertilize crops. Thus, the quality of treated sewage is often related to its expected reuse.

> There needs to be concerted effort by government agencies, nongovernmental organizations, and other stakeholders at all levels to provide both basic sanitation facilities and environmental education.

Decentralized systems are already being used in some EU countries. Such systems would appear to offer a suitable solution for Lagos State's wastewater treatment problems. A sustainable decentralized system would not be water-intensive, and its lower cost would make it affordable.

Observations and Recommendations

Most inhabitants of Lagos State live in clusters of high population density and low water usage. Poverty is relatively high. The community could benefit from a decentralized system of wastewater management.

Such decentralized systems have been shown to be adaptable and suitable for community infrastructure. They require simple construction techniques, making them easy for small-scale contractors in Lagos State to construct (Butler & MacCormick, 1996; Venhuizen, 1997a). Decentralized wastewater management systems can be employed by households, as well as by institutions such as schools, colleges, universities, mili-

tary facilities, residential flats, and areas of new residential construction.

However, if satisfactory, low-cost wastewater pretreatment and posttreatment are to be achieved on-site at the community level in Lagos State, effective management and maintenance programs will be needed. Good management will be required to ensure protection of public health and the environment, as well as recovery and reuse of wastewater resources.

In Lagos, disease frequently arises from unhygienic and contaminated domestic environments, poor quality waste management, and unsanitary disposal of human waste. There needs to be concerted effort by government agencies, nongovernmental organizations, and other stakeholders at all levels to provide both basic sanitation facilities and environmental education.

Based on the research discussed here, we would make the following observations and recommendations regarding wastewater management in Nigeria's Lagos State:

- Accelerated extension of wastewater management services to all communities is essential in order to address concerns about water scarcity, water pollution, and protection of public health.
- In addressing the needs of communities, planners and decision makers should favor the adoption of a decentralized system of wastewater management, which is less costly and less water-intensive than conventional systems. A decentralized approach would better meet the needs of Lagos State, where water is scarce and financial resources are limited.
- Accelerated expansion of wastewater services to all communities in Lagos State requires the adoption of cost-effective solutions that are affordable to both the local and the national economies.

- Given the water resource crisis that is looming in Lagos State, wastewater should be recognized as part of the total water cycle and should be managed within an integrated water resources management process. The following principles should govern development of wastewater services for the communities of Lagos State:
  - ❖ The volume of water used in wastewater management should be considerably reduced.
  - ❖ Wastewater should be seen as a resource that must be recovered and reused.
  - ❖ Management of wastewater should be holistic. Management programs should carefully consider all aspects of waste generation, transport, treatment, and re-integration.
  - ❖ Wastewater should be managed as close as possible to the source where it is generated and where its beneficial reuse will take place.
- Holistic management of wastewater in Lagos State should start at home, in the sense that generation of wastewater should be minimized.

Concluding Thoughts

Decentralized wastewater treatment systems are inexpensive and do not require intensive water use, making them suitable for conditions in Lagos State. These systems can offer the same benefits and convenience as conventional wastewater treatment systems. However, they can be implemented at lower financial cost and offer better prospects for long-term, large-scale solutions, thus enabling faster and more sustainable expansion of sanitation services. Accordingly, adoption of a decentralized wastewater management approach can be recommended for Lagos State.

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