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WASTEWATER MANAGEMENT IN A NIGERIAN LEPER COLONY

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Abstract. Wastewater from infected leprosy patients is expected to contain considerably higher concentrations of pathogens than standard domestic wastewater and, therefore, is more infectious. Isolation of lepers' is thought to prevent the spread of a wide range of infectious diseases that could potentially be contacted through direct or indirect exposure from an infected person's wastewater in the surrounding environment. However, inappropriate management of wastewater and sewage from these camps has led to contamination of the surrounding environment, typical in Nigeria. This study aims to recommend safe, efficient and sustainable management of wastewater and sewage in a lepers' colony in Ogbomosho, south west Nigeria. The case study is privately owned, with three camps and a leprosarium. Information and data (primary and secondary) were collected from medical personnel (doctors, matrons and nurses), management staff and lepers in each camp, through hand- delivered and orally explained questionnaires and physical observations. Wastewater samples could not be collected for analysis because there were no septic tanks or drainage for sewage and wastewater disposal. Two of the camps have no sanitary disposal system, with the remaining camp occupying one pit latrine, which is inadequate in prevention of environmental pollution. The leprosarium itself uses the pit latrine as an improvised bathroom and for defecation. Therefore, a further aim of this work is to provide a sewage treatment facility to cope with the problem of unsanitary disposal of excreta. The majority of wastewater is generated from bathing, personal washing, ward clean-ups, patients' services and general house-keeping activities. The approximate quantity of water being used per head per day was found to be 64–79 litres, resulting in ~60 litres of wastewater that was discharged without treatment. To ameliorate environmental risks that leper colonies are responsible for, the pour-flush toilet was recommended based on its suitability for the physical condition of lepers, its ease of operation, maintenance and sustainability, minimum water usage for flushing and low construction costs. However, this must be fed into a well designed and sited septic tank and soak-away pit to receive foul sewage and sullage, respectively. Ideally, construction of a proper in-built bathroom is recommended for both the leprosarium and camps.

Keywords: wastewater, management, environment, policy, infection, sanitary facilities, sustainability.

1. Introduction

The fundamental engineering principles involved in the collection, treatment and disposal of waste play an important role in achieving a pollution-free environment. To achieve best results, effluents should be subjected to post – treatment though some processes can come out to be very expensive (Blonskaja, Zub 2009). In many developing countries, leper patients have no access to sanitary facilities or an adequate supply of poTable water. Prominent features of any leper colony are improper disposal and inappropriate management of wastewater, therefore creating a high direct or indirect risk of infection to other people in close proximity to the leprosarium. Coker *et al.* (2008) addressed the poor management of solid waste in such a society in Nigeria. The spread of a wide range of communicable and infectious diseases has been linked to improper sewage management. Wastewater from the leprosarium and infected patients may contain higher concentrations of pathogens than domestic wastewater. This stresses the importance of providing access to adequate sanitary facilities and proper sewage treatment in every leprosarium, to prevent faecal-oral transmission through contaminated surface and groundwater. Other transmission routes include penetration into the skin when in contact with infectious wastewater or direct inhalation of infected air due to over crowdedness or poor ventilation in the colony.

Sewage is defined as including faeces, kitchen wastewater, bathroom wastewater, surface runoff from rain, laundry wastewater, and/or industrial wastewater (Oluwande 1978), whereas wastewater could be either domestic (sanitary) or industrial used water. There are two fundamental reasons for treating sewage (Gray 1989):

1. To prevent pollution and thereby protect the environment.
2. To protect public health by safe guarding water supplies and preventing the spread of water diseases.

In addition, wastewater treatment serves to:

1. Prevent the release of an offensive odour into the air.
2. Prevent the destruction of aquatic life where it is been disposed.
3. Prevent soil from experiencing "sewage sickness".

The hazardous implications of lepers' colonies on the environment have not been examined to date. With attention already drawn to the haphazard management of solid waste in a Nigerian leper colony (Coker *et al.* 2008), this study further examines sewage and wastewater management within the same colony, but from an environmental perspective. The aim is to implement a sustainable design that will improve the lifestyle of the disadvantaged residents**.**

2. Leprosy

2.1. The cause

Leprosy is one of the earliest diseases to have been recorded. Some of its clinical signs have been identified from descriptions given in the ancient literatures of Egypt, India and Israel. But it was not until 1873 that the Norwegian physician Dr G. H. Armauer Hansen discovered Mycobacterium leprae, the first bacterium to be identified as causing a major disease in man. Before (and even since) this discovery, many other theories existed about the cause of leprosy; that it was a curse from God or a punishment for one's own sins or the sins of others; that it was related to the law of karma or witchcraft; and that it was due to eating certain foods, hereditary disposition or even sudden changes of temperature (Tom 2003). According to Webster's Third New International Dictionary, leprosy is "a chronic disease caused by infection with an acid-fast bacillus (Mycobacterium leprae) and characterized by the formation of nodules on the surface of the body and especially on the face, or by the appearance of tuberculoid macules on the skin that enlarge and spread and are accompanied by the loss of sensation, followed sooner or later in both types by the involvement of nerves with eventual paralysis, wasting of muscle, and production of deformities and mutilations".

2.2. Transmission

Leprosy is a communicable disease, and the human being is the only known route through which other human beings can become infected. Although the process is not fully understood, it is thought that the bacillus is passed from one person to another through the skin and upper respiratory tract. People with untreated multibacillary types of the disease are the main sources of infection. The household contacts of these untreated multibacillary patients are the population most at risk.

The impairment usually involves the invasion of the nerve fibres, the skin, the eyes and the mucous linings of the nose and other parts of the body. Damage to the nerve trunks that control sensibility and motor functions is particularly common. Damage can be done to the nerves in the limbs, causing the hands and feet to lose their sensibility and become paralysed and contracted. If these extremities are not protected, they can easily incur further injury; the damaged nerves can no longer transmit pain and so an important warning mechanism is lost. People affected in this way will not automatically withdraw their hands from the heat of a fire or adjust their stride to avoid putting too much pressure on the ball of the foot (Tom 2003).

Multidrug therapy (MDT) medicines, provided free by the World Health Organization (WHO), have notably reduced the number of global leprosy patients from 805,000 in 1995 to 286,000 in 2000 (WHO 2006). As a consequence, in recent years improved awareness encouraged many countries to change their isolation policies. Most notably in Japan, where interment policy led to many patients tragedies (Mori and Ishii 2006), long standing (since 1915) leprosy patient sterilization policies (Kataoka *et al.* 1998) were abolished. However the psychological scaring of the leprosy stigma is deep-seated. For example, patients in Korea still chose to dwell in their leprosarium after they have been fully cured (Sase 2004). Similarly, in Ghana the government provides leprosy colonies with rent-free, purpose-built housing, which means following recovery, patients are financially secure and can remain in the leprosarium.

2.3. Leprosy settlements

Lepers are forced to live in colonies (leprosaria) far from the domain of healthy people, until they are fully treated. Even those who have been cured of their leprosy and are certified healthy are hardly ever embraced by their people because of the stigma. Originally, leprosy was thought to be a hereditary disease. During the European Middle Ages (500–1500 AD), leprosy sufferers were made to wear particular clothing and ring a bell to warn others of their approach. Even during modern times, leprosy suffers were isolated in separate hospitals and colonies. Despite WHO eliminating leprosy (prevalence rate of < 1 per 10,000 inhabitants) (WHO 2006), unfortunately, even today leprosy patients are still housed in isolated settlements in some developing countries. Examples include Douala colony, Douala, Cameroon; Makete leprosarium, Tukuyu, Tanzania; IIha Grande colony, Rio de Janeiro, Brazil; Kuala Lumpur government leper colony, Kuala, Kuala Lumpur, Malaysia; Sudan Interior Mission, Kano, Nigeria (ILA 2006).

Discharged residents often chose to live in settlements near the leprosaria. These were precarious com-

munities, set up without planning or infrastructure. Sometimes the former residents were given land by the leprosarium, sometimes they bought it and sometimes they simply squatted on it.

People chose to live in these settlements for a variety of reasons. They could receive medical treatment that would be denied elsewhere and could escape from the rigid rules of the institution. For example, unmarried residents could live together if they wished. Above all, they would be among their own kind and would not face rejection. There were also economic reasons including cheap land close to the leprosaria. Many settlement residents worked in the leprosarium or received benefits from it, such as food, clothing and medical treatment. Ties between the leprosarium and the settlement were usually very close. People in the settlement continued to use the facilities of the leprosarium just as they had when they were residents, visiting friends whenever they chose. If a leprosarium closed down, this often resulted in closing of the settlement as well (Tom 2003).

2.4. Population of the infected

Leprosy strikes all age groups and is primarily associated with poor living conditions. Both sexes are affected, but male cases are reported more often than females. Exact figures of infected populations are impossible to obtain, but conservative estimates suggest that at least six million people are currently affected by leprosy. Tables 1a, 1b show WHO records for selected countries. Of these six million, some have been cured and have few physical or psycho-social scars. The majority of these people probably no longer need medical services or socio-economic support, but many will continue to need support after their cure. Approximately three million people currently affected by leprosy have moderate to severe physical disabilities and many more have lost some physical sensation or have been affected socially, economically or psychologically. The scars of these people may not be visible, but they are just as real as physical disabilities, proving that there is still much to be achieved. For the general population, however, the case detection rate for leprosy has recently held steady at about 6–700,000 new cases each year, which is a cause for concern.

Table 1a. Number of new leprosy cases detected during 2002 in WHO regions (WHO 2003)

WHO region	No of new cases detected during 2002
Africa	48,248
Americas	39,939
South-east Asia	520,632
Rest of world	11,853
Total	620,672

Table 1b. Largest numbers of leprosy cases detected during 2002 in world countries (WHO 2003)

Country	Largest No of cases detected during 2002
India	473,658
Brazil	38,365
Nepal	13,830
Indonesia	12,377
Bangladesh	9,844
Myanmar	7,386
Tanzania	6,497
Mozambique	5,830
Madagascar	5,482
Nigeria	5,078
D.R. Congo	5,037

* In addition, the following countries still had prevalence rates >1 per 10,000 populations: Angola, Cameroon, Central African Republic, Comoros, Congo, Guinea, Liberia, Papua New Guinea and Timor-Lest.

The present burden of residual leprosy (~220,000 prevalence cases worldwide during 2006) is endured by the developing world, including Nigeria (WHO 2007). Sokoto and Zaria, two major cities in Northern Nigeria with frequent cases of leprosy, used to have relatively well equipped colonies. However, due to poor maintenance and inadequate government and stakeholder funding, both colonies have deteriorated. Despite Nigeria joining other nations to observe the 54th World Leprosy Day Anniversary (27 January 2007), greater attention needs to be directed to the management of health care centres and associated patients' health risks.

At present, neither Nigeria's Federal Ministry of Health nor its counterpart, Oyo State Ministry of Health, retains archived information about national leper colonies and neither of the Ministries offer guidance on waste management practices. In most countries there are appropriate formal directives to promote and ensure adherence to proper waste management practices, especially in regard to medical waste. But in Nigeria, there are presently no formal policies or directives concerning medical waste management strategies, particularly waste disposal from a leper colony.

There has been insufficient research published on leprosaria and associated residents, probably due to the taboo factor. Therefore, this case study in Ogbomosho, south west Nigeria, attempts to:

- Determine impacts of sewage and wastewater pollution and contamination.
- Recommend efficient sewage management options for the leper colony.
- Provide future trends and event predictions for circumstances when only inefficient sewage treatment techniques could be provided for the lepers.

3. Methodology

3.1. Study area

A privately owned colony for lepers in the south western region of Nigeria, consisting of three camps, denoted C1, C2 and C3, along with a health-care centre or leprosarium, was selected for this study. Each camp varied in size, population and site location, but all were situated within the same colony and settlement. The leprosarium, exclusively for lepers, contained the following:

- Wards (separate wards for males and females),
- Laboratory,
- Store,
- Consultation room,

−Doctor quarters,
−Recreation unit,
−Rehabilitation centre/workshop,
−Kitchen,
−Laundry unit,
−Milling unit.

Fig. 1 displays the layout of the leprosarium. The colony employs eight staff including a doctor, a matron, three nurses and one waste handler. Each of the nurses is responsible for managing the patients in a camp, guided by the matron who, subsequently, reports to the doctor (Head of leprosarium).

3.2. Data collection

There were 30 patients in the leprosarium during the study period (August to November 2006). The ethical consensus of the inhabitants and of the State Ministry of Health was obtained prior to the study. Data was collected through field survey/physical observation and oral and written interviews, consisting of structured questionnaires completed by the medical doctors, nurses, administrative staff and some assessable lepers. These are further detailed as follows:

Management and health-care staff (Doctor, Matron and Nurses) were interviewed to review details about leprosarium administration approaches including patient facilities, extent of understanding and views on sanitation and sewage management, and implications for improvement. Management, health-care staff, patients and ward-aids were surveyed via questionnaires, comprising of four modules. The questions were conveyed orally to illiterate patients. Module I was administered to the medical doctor to obtain information on the health and condition of the leper with regards to exposure to and in-sanitary disposal of sewage. Module II was designed for the matrons and nurses to obtain the sources and estimations of wastewater quantities produced in the leprosarium, per head per day, as well as to determine the impact of in-sanitary disposal of wastewater on the health condition of the lepers and visitors to the leprosarium and camp. Module III, administered for management staff, aimed to determine opinions on environmental protection and methods of sewage collection, treatment and disposal for the entire colony. Opinions on the general well-being of the lepers were also assessed. Module IV was administered to the lepers to obtain information on condition of the sanitary facilities.

Field observations were used to complement and ascertain data obtained from both the interviews and questionnaires survey. Observations were recorded at different locations within the leprosarium and camps including sanitary facility sites, characteristics of which are detailed in Table 2.

4. Results

4.1. Leprosy cases

Responses of the questionnaires revealed that new leprosy cases (n = 110) were primarily contacted and transmitted through crowdedness, inadequate housing ventilation (Fig. 1) and poor personal and environmental sanitation. The number of new cases of leprosy infection detected in this study area, from 2000–2006, is shown in Table 3. There were higher numbers of males contracting the disease than females, as females tend to maintain a higher level of personal hygiene and sanitation.

Table 2. Sanitary characteristics of the camps

Country	Camp 1	Camp 2	Camp 3
Number of rooms	12	20	35
Previous Number of people per room	2–3	variable	4
Present Number of people per room (including children)	1–3	1–4	1–3
Total Number of people*	24–25	40–45	70–75
Economic activities	Farming	Farming	Farming
Water Supply	Well Borehole	Well	Well Borehole
Toilet type	None	Pit	None
Number of toilets	None	3	None
Number of bathrooms	None	4	None
Type of ventilation	Single (small)	Cross	Single (small)
Excreta disposal method	Open field	Pit	Open field
Source of wastewater	Bathing Cooking Food prep/wash	Bathing Cooking Food prep/wash	Bathing Cooking Food prep/wash
Wastewater management	None	None	None

*Assuming a maximum of two people per room, excluding children.

Table 3. Number of new leprosy cases detected from 2000–2006 (WHO 2007)

Year	Male	Female	Age (years)	Total
2000	11	8	24–75	19
2001	9	7	9–65	16
2002	14	6	20–75	20
2003	15	7	21–66	22
2004	6	4	9–60	10
2005	9	7	11–75	16
2006	4	3	9–70	7
			Total	**110**

Variations exist between the numbers of people infected in each year, indicating that the disease is yet to be eliminated and there is every possibility that numbers of new cases will increase during the next 1–2 years. This could be due to relaxation in preventative action, once reduced trend targets are met, resulting in reoccurrence of the disease. If there are no proper strategic sewage and housing management plans to alleviate the spread of leprosy, it is possible that unaffected children, relatives or guardians may become infected through inhaling the microbes which carry the disease through improper ventilation. Primary observations revealed that there was no

existing institutionally enforced sewage and sanitary management, resulting in open-bush defecation and open discharge of wastewater.

4.2. Quantity of wastewater generated

Wastewater from the leprosarium and camps was expected to be more infectious and polluted than normal domestic wastewater, as it contained infected sputum/spit, body fluid/sweat and urine, as well as bathing and washing wastewater. Therefore, it was not handled without care. Wastewater generation, in all camps, depended on water usage, daily activities, size of each camp/colony, wastewater management techniques, amount of infiltration and amount of rainfall (Fig. 2). Variations in wastewater quantities during the week were small (Table 4), except in homes where major household laundry, especially washing of children's clothing, took place. The small variations in wastewater quantities between camps were mainly due to differing populations, affecting quantities of wastewater from food and drink preparation, washing and personal cleaning.

Table 4. Approximate volumes of water utilized

Water usage*	Leprosarium	Camp 1	Camp 2	Camp 3
Bathing	15	15	15	15
Personal washing	(100/Wk) 15	(70/Wk) 10	(70/Wk) 10	(70/Wk) 10
Food preparation	10	15	20	20
Dish washing	2	7	10	10
Drinking	2	2	2	2
Nurses clean ups	4	–	–	–
Patients services	1	–	–	–
Ward/room clean ups	(70/Wk) 10	5	5	5
Hospital laundry	(70/Wk) 10	–	–	–
Miscellaneous	10	10	10	10
Total	79	64	72	72

* Units in litres per head per day.

All nasal discharges, spit, sputum and other bodily fluids generated from the lepers, were taken care of by the individual, at any convenient place. However, the provision of sewage facilities should serve as a means of personal disposal of all individual waste.

4.3. Pathogenic exposure within the colony

In all camps there were no kitchens, therefore, all wastewater from kitchen activities were disposed off on the ground surface. This, along with disposal of sewage and wastewater, increased exposure of pathogens, which percolated into the groundwater (Figs 3, 4) and, subsequently, flowed into surface water. Pathogens can become exposed to man and animals both directly and indirectly. Direct contact occurs through unintentional contact with wastewater, including walking on ground where faeces were discharged or inhaling airborne microbes.

Fig. 1. Front view of part of camp 2 showing room arrangements with poor ventilation systems

Fig. 2. The leprosarium with centralized concrete rain-water harvesting tank and 3 galvanized iron tanks for water storage

Fig. 3. View of behind the bathroom in camp 2 where wastewater percolates directly into the soil

Fig. 4. Back view of an improvised bathroom for the leprosarium. Wastewater percolates into the soil

Fig. 5. Front view of the pit latrine in camp 2 where flies tend to breed due to exposure from a damaged door

Fig. 6. Ventilated improved pit (VIP) toilet for the leprosarium

Indirect contact occurs through consumption of pathogen-contaminated food, such as crops grown on untreated wastewater or sewage disposal sites, or from contaminated milk and other animal products from animals fed with contaminated crops. Other sources were consumption of fish contaminated by run-off from a sewage disposal site, or by coming into contact with grazing animals and rodents already contaminated with wastewater and sewage effluents (Fig. 5). The former can be prevented by limiting human/animal contact with sewage, through installation of toilets (Fig. 6) and proper wastewater treatment and disposal systems, while the latter can be avoided by reducing the attractiveness of the sewage effluent to disease vectors, such as insects, birds, rodents and other living organisms that can transport pathogens. Another indirect contact is through the ingestion of contaminated run-off water, from nearby land application sites, during recreational activities.

5. Discussion on environmental impact of unsanitary disposal of wastewater

Wastewater generated in the leprosarium was more infectious than ordinary domestic wastewater, due to contamination by pathogenic organisms from human sputum and general hospital cleaning. Previous work identified that uncontrolled discharges of wastewater from field hospitals treating cholera patients had been strongly linked to cholera epidemics in some Latin American Countries (Pruss *et al.* 1999). It is suspected that many cases of infection, with a wide variety of pathogens, have resulted from exposure to improper management of wastewater in developing countries. The Towards Sustainability report (CEC 1992) revealed trends that could have devastating consequences on the quality of the environment if nothing is implemented to manage wastewater.

The environment is structured in several ways. For example, one environmental component could focus primarily on biological components, including all media susceptible to air-, water- and soil-pollution, while others concentrate on the flora and fauna, human beings, the landscape, urban and rural conservation and the built heritage (DoE 1991). The DoE check list given in Table 5, outlines the effects of unsanitary disposal of sewage on the physical environment.

Table 5. Environmental impacts of discharged wastewater (DoE 1991)

Physical environment	Impact
Air and atmosphere	Air quality (foul odour, contaminated air/wind)
Water resources and water bodies	Water quality and quantity (contamination)
Soil and geology	Classification, risks (erosion, contamination)
Flora and fauna	Specific birds, mammals, fish, etc, can become extinct Reduction in life span Aquatic, terrestrial and vegetation contamination
Human beings	Physical, mental health and well-being (exposure to diseases) Longevity – reduction in life span
Landscape	Characteristics and quality of landscape
Housing and Climate	Structural deterioration, dampness and temperature changes

Approaches to wastewater disposal at the leprosarium are primitive. In Nigeria, a typical developing African nation, there is limited awareness of the contribution of unsanitary wastewater disposal to environmental pollution. This is reflected by the lack of implementation of wastewater discharge policies to deal with medical wastewater, which is deemed to be hazardous. It is recognized that this leprosarium establishment generates a variety of wastewater, some of which is related to household wastewater, such as from bathrooms, kitchens, washing and general household cleaning), while other hazardous wastewater includes wastewater from wound treatment, washing of blood-contaminated materials and rinsing of sputum from the mouth. Unfortunately there is no formal policy to regulate the generation and management of wastewater in Nigeria. In fact, the National Waste Management policy, embodied in the National Policy on the Environment (NPE) (formulated in 1989, and revised in 1999) only equates to hazardous waste and does not refer to medical wastewater (Federal Ministry of Environment 2006). Although, the leprosarium was served by medically trained staff, ward-aids had no formal training and received no protective clothing (Coker *et al.*

2008). Many reported that occupational health incidents, even in advanced nations, were linked to inadequate or improper wastewater discharging procedures (Blenkharn 1995).

Unsanitary disposal of wastewater, therefore, affects all aspects of the physical environmental components both directly and indirectly. Establishment of an environmental protection baseline requires information on both the present and expected future environmental conditions as a result of wastewater disposal.

The leprosarium had primitive living standards, including no electricity or ventilation; only pit latrines and poor water supply, which were not favourable for patients' relaxation and recovery (Power 1939). Unfortunately, Nigeria suffers from a deterioration of health-care institutes (Iwunze 2007) following inadequate government budgetary health-care allocations (Central Bank of Nigeria 2001). For example, in 1998 the Nigerian Government only spent 5.5% of GDP on health-related programs, which is low even by African standards. This figure steadily decreased to 4.7% in 2002 (Falola, Heaton 2006) and was remarked on by the leprosarium management team who recognize the need for government investment to enhance patients' health-care and provide appropriate amenities for a modern health service. It is ironical that the cry of Abolitionists, in the first days of the anti-slavery movement, is still applicable to leprosaria in Nigeria; "Am I not a man and a brother?''. It is completely inappropriate that such people should be treated with degradation and neglect.

The international recognition that family units are entitled to one toilet, one bathroom and one water supply system may not be possible for the lepers because the infection is usually prevented before it affects the entire family. The individual infected with the disease is isolated, accounting for the main reason why the colonies exist. However, the minimum requirements for a satisfactory system of sanitation in this particular colony are:

- The system must be cheap.
- It should use minimum or none of the potable water supply for its operation.
- It should operate well, despite misuse.
- It will require little supervision and maintenance.
- It will dispose of all the wastewater.
- Wastewater will be treated to a degree where it can be discharged with little danger to the user and the environment.
- It should require no mechanical equipment.

6. Conclusions and recommendations

Rates of environmental improvement, in most leper colonies in Nigeria, have slowed down drastically in this millennium. Associated sanitation and housing standards are also under severe pressure and have declined. Sewage and housing management should be a primary issue in the on-going conflict for a cleaner, healthier and safer environment for the lepers, medical staff and visitors to the colony, as well as the entire public. Currently, there is no formal policy on the regulation of wastewater from health-care facilities in Nigeria. The Federal Ministry of Environment is yet to document or enforce relevant laws and regulations relating to methods for treating and disposing of medical wastewater. The National Waste Compliance Monitoring Unit oversees solid waste management issues and monitors waste disposal, but it does not include medical wastewater. This study has revealed that the leprosarium had infectious wastewater when compared to other health-care centres. The patients have had to apply self-help initiatives, sometimes discharging their individual waste indiscriminately wherever available. They also defecate on open ground in the bush. Their bathroom facilities are sub-standard. It is clear, however, that with a change of policy and investment, many benefits could be imposed onto patients, staff and the environment. Therefore, the following recommendations are suggested:

- The construction of pour-flush toilets is recommended due to low operation and construction costs and ease of construction, operation and maintenance, including:
  i) Only ~1–3 litres per flush are required, compared to ~10–20 litres for conventional systems.
  ii) There is no need for flushing equipment as it requires manual flushing.
  iii) Flies are deterred by the carefully designed squatting pan, which lies below the water seal of about 15–25 mm deep, also preventing odour.
  iv) The need for a multiple tap in-house water supply system.
  v) The pit can be desludged either manually or mechanically. It is also easier to empty than a pit directly beneath the seal.
  vi) Since it was discovered that all the lepers cannot afford the use of sanitary (tissue) paper, this design is particularly suiTable wherever water is used for anal cleaning.
- A public awareness campaign to highlight the importance of maintaining personal hygiene. The lepers education program should include:
  i) Information on the role and responsibilities of each individual in achieving a clean and safe environment.
  ii) Information on all aspects of wastewater policies.
- The effective implementation of:
  i) Weekly sanitation programmes by assigning monitoring teams to all leper colonies to promote cleanliness. Provision of hand-washing facilities should be an integral part of this sanitation programme in the form of wash basins or simple clay pots adjacent to the toilet, which should also be accessible to children.
  ii) Camp to camp and house to house regular surveys and monitoring.
- Enforcement of housing standards by the provision of housing facilities, including water supply, sanitary facilities, road/drainage, electricity, etc.

- Provision of checklists, to be completed by management staff, aimed at recording observed methods of managing wastewater and on-the-spot evaluations of the sanitary state of the leper colony.
- Regular renovation and repair of buildings, not just when the need arises for improved health condition. These include roofing, ceiling, flooring and plastering, as well as other important building services.
- Provision and construction of improved building infrastructure, planned in such a way to encourage 'homely' environments and not just shelters. Ideally, these should conveniently house at least a family of five, as opposed to a single man room. It should also enhance cross ventilation within the building.
- Installation of communication and social amenities, such as electricity and good road networks, to facilitate communication and interaction both internally and externally from the camp.
- Daily, weekly, monthly and semi-annual maintenance of the structures in the colony, should pay special attention to areas requiring reinstallation or rehabilitation.
- National policy makers will be responsible for sanitation and waste disposal to:
  i) Implement effluent standards.
  ii) Recommend treatment and safe disposal methods for wastewater.
  iii) Implement health policies with regard to appropriate disposal of excreta.
  iv) Ensure that monitoring procedures are incorporated into wastewater/sewage management plans.
  v) Legislate and regulate policy aspects of general waste, environmental safety, air and water quality, and prevention and control of infections.
- National, State and local budgets for the well-being of lepers.
- Provision of adequate water supply and sanitation facilities for patients, staff and visitors in all leper colonies.
- For the sanitary facilities to benefit the lepers, staff and all visitors to the colony, a change in social attitude and habits is required, so as to properly maintain these facilities.
- In order to generate funds within the colony, the previously closed rehabilitation centre should be reopened, as this was an educational environment where lepers could carry out crafts, such as weaving, to supplement personal income, which otherwise is obtained from agricultural activities.
- Government, private and voluntary interventions are expected to provide funds, not only for medical needs, but also to incorporate sewage and housing management in the plan or budget.
- Further research is necessary to increase knowledge of:
  i) The extent to which wastewater is contaminated.
  ii) The risk level for infection of the exposed population.
  iii) Growth and survival of pathogens in wastewater during treatment storage after sanitary facilities have been installed.

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RAUPSAIS UŽSIKRĖTUSIŲ ŽMONIŲ KOLONIJOS NUOTEKŲ TVARKYMAS NIGERIJOJE

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Santrauka

Manoma, kad raupsais užsikrėtusių pacientų naudoto vandens nuotekose gali būti padidėjusi patogeninių organizmų koncentracija, palyginti su nuotekomis iš gyvenamųjų namų. Manyta, kad raupsuotųjų izoliavimas sulaikys šios infekcinės ligos plitimą didesniu mastu, nes mažiau infekuotųjų nuotekų pateks į aplinką. Vis dėlto netinkamas nuotekų tvarkymas Nigerijoje lėmė stovyklas supančios aplinkos užteršimą. Darbo tikslas – pateikti rekomendacijų, kaip saugiau, efektyviau ir tvariau sutvarkyti nuotekų valymo sistemą Ogbomosho kolonijoje pietvakarių Nigerijoje. Teikiant rekomendacijas remtasi trijų privačioje teritorijoje esančių stovyklų ir leprozoriumo pavyzdžiu. Kiekvienoje stovykloje informacija ir duomenys (pirminiai ir antriniai) buvo surinkti iš medicinos sektoriaus personalo (gydytojų, seselių), administracijos ir raupsais užsikrėtusių žmonių užpildytų anketų ar apklausus žodžiu bei apžiūrėjus fiziškai. Nuotekų mėginiai negalėjo būti paimti, nes nebuvo surinkimo tankų ar nuotekų kanalizacijos sistemos. Dvi stovyklos neturi sanitarinės šalinimo sistemos, trečioji stovykla turi vieną iškastą duobę. Tai visiškai neatitinka aplinkosauginių reikalavimų. Pačiame leprozoriume iškastos duobės naudojamos kaip improvizuoti vonios kambariai ir tualetai. Tolesnis šio darbo tikslas – numatyti valymo įrenginius, kurie padėtų įveikti šias problemas. Didelė dalis nuotekų susidaro maudymosi, skalbimo, palatų valymo, pacientų aptarnavimo ir buities darbų metu. Apytiksliai venas žmogus per dieną sunaudoja 64–79 litrus vandens, gi nesutvarkytų nuotekų išleidžiama apie 60 litrų per dieną. Dėl raupsais užsikrėtusių žmonių kylančiam pavojui aplinkai sumažinti rekomenduota naudoti vandens nuleidimo sistemą tualetuose. Vandens nuleidimo sistemos įdiegimas yra tvarus sprendimas, nes nėra brangus, o pasiekiama, kad vandens būtų sunaudojama minimaliai. Be to, nutekamasis vanduo turi būti surenkamas tam skirtuose tankuose ir duobėse. Idealiu atveju – ir leprozoriume, ir stovyklose rekomenduotina įrengti tinkamus vonios kambarius.

Reikšminiai žodžiai: nuotekos, tvarkymas, aplinka, politika, infekcija, sanitarinė įranga, tvarumas.

ПРИВЕДЕНИЕ В ПОРЯДОК СИСТЕМЫ СТОКОВ В КОЛОНИИ ЗАРАЖЕННЫХ ПРОКАЗОЙ ЛЮДЕЙ В НИГЕРИИ

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Резюме

Считается, что в сточных водах из колоний зараженных проказой людей может быть увеличена концентрация патогенных организмов по сравнению со сточными водами из жилых домов. Ранее предполагалось, что изоляция зараженных проказой людей предотвратит распространение этой инфекционной болезни в большом масштабе благодаря уменьшению возможности попадания в окружающую среду инфицированных сточных вод. Однако из-за характерной для Нигерии плохой очистки сточных вод окружающая колонию среда оказалась загрязненной. В работе приводятся рекомендации, как безопаснее и эффективнее оборудовать систему очистки сточных вод в колонии Огбомошо на юго-западе Нигерии. Рекомендации приводятся на примере трех лагерей и лепрозория, находящихся на частной территории. Информация и другие данные (первичные и вторичные) в каждом лагере были получены у медицинского персонала (врачей, старших сестер и др.), администрации и зараженных проказой людей, которые опрашивались устно, осматривались физически или заполняли розданные им анкеты опроса. Образцы сточных вод не забирались, так как не существовало танков для сбора стоков или канализационной системы. В двух лагерях не было санитарной системы для удаления стоков, в третьей была выкопана одна яма, что совершенно не удовлетворяет природоохранных требований. В самом лепрозории выкопанные ямы использовались как импровизированные ванные комнаты и туалеты. Поэтому целью работы было способствовать внедрению очистных сооружений, которые могли бы решить существующую антисанитарную проблему. Большую часть сточных вод составляет вода, загрязненная во время купания, стирки, уборки палат, обслуживания пациентов и бытовых

работ. Один человек за день использует приблизительно 64–79 литров воды, в то время как за день спускается около 60 литров неочищенных отходов. Для того, чтобы снизить опасность для окружающей среды от прокаженных людей, было рекомендовано использовать систему спуска воды в туалетах в зависимости от физического состояния зараженных проказой людей, что улучшило бы возможности использования воды и приведения в порядок системы стока. Внедрение системы спуска воды является наиболее приемлемым решением, так как не требует больших материальных затрат и ограничивается минимальным количеством используемой воды. Сточная вода должна собираться в предназначенных для этого танках и ямах. В идеальном случае оборудование соответствующих ванных комнат рекомендовано как для лепрозория, так и для лагерей.

Ключевые слова: стоки, приведение в порядок, окружающая среда, политика, инфекция, санитарное оборудование.

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