Appropriate Technology for Sustainable Municipal Sewage Treatment in Yola, Adamawa State, Nigeria

Ibrahim Saidu

ABSTRACT

The current discharge of enormous quantities of untreated sewage released into water bodies containing several substances that are hazardous to aquatic life and public health is a major environmental and economic concern in Yola. The bottlenecks occasioned by the absence of sewage treatment plant to which sewers are usually connected for conveyance of the sewage for eventual treatment of the phenomenon before its discharge into the environment, are well documented. Application of alternative innovative approaches to sewage treatment technologies is not understood and several constraints to their adoption exist. Sewage best management practices are the application of modern technologies for sewage treatment to address the issues of water quality, quantities, and amenity for long term sustainability. This study propses an appropriate technology for the treatment of sewage in the study area.

Keywords: *Technology, Sewage, Treatment plant, Parameters, Quality Sludge*

INTRODUCTION

Sewage is disposed off, or left to wonder in its chosen courses, either in gutter, culvert, along the road, or flow into other streams or individual septic tanks untreated in almost all the urban centres in Nigeria. Consequently, stagnated sewage in the gutters are convenient places for breading mosquitoes which are key transmitting agents of malaria and related ailments. Others sink into the ground and end up polluting the groundwater. Sewage require treatment before it can safely be buried, used or conveyed, or released back into local water systems. In a nutshell, the common approach of the day is to throw the sewage out the door and window. This is not the case in cities in the developed world, as sewage effluents from residential, commercial, and industrial areas are conveyed through sewerage systems to treatment plants.

There is clear evidence within Yola that the current systems of sewage is unsuitable and that the study area has the opportunity to learn from the best practice applied in other countries and adopt an alternative innovative approaches to sewage management. This work highlights the appropriate innovative technology that needs to be adopted and applied in the treatment of sewage and the potential lessons that can be learnt for Yola practice. It also emphasizes the importance of education in a proper application of such a technology. The area of study is made up of Jimeta metropolis and Yola town, jointly referred to as

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Yola, with the former, housing the Adamawa State capital. It lies on longitude 12°29E and latitude 9°12N (Fig.1) having the total land area of 1,213km^2 (Rahalt,1995). The total population of the people in the study area is 392,854 (Saidu, 2012). The study area lies along the southern flanks of the River Benue on Bima sandstones (600-900m thick) and alluvium sediments related to the River Benue system. The Sediments were deposited in shallow environment during the transgressive phase when the Benue-Chad-Rift valley and its eastern segment in the former Adamawa province began to subside in the cenomanian such that heteropic deposits occurring with coarse elastics are most common (Rahalt, 1995). Yola has a tropical wet and dry climates (Aw), with the rainy season beginning in April and terminating in late October, lasting about six months. The average rainfall for the study area is 957.9mm while the minimum and the maximum temperatures are 21.2°C and 34.5°C, respectively (Adebayo, 1999). The vegetation in the study area is generally short savanna grassland type with occasional trees. The pattern of urban landuse is dominated by residential landuse on one hand, and the persistent mixed land use being observed between residential and commercial landuses, in particular, on another.

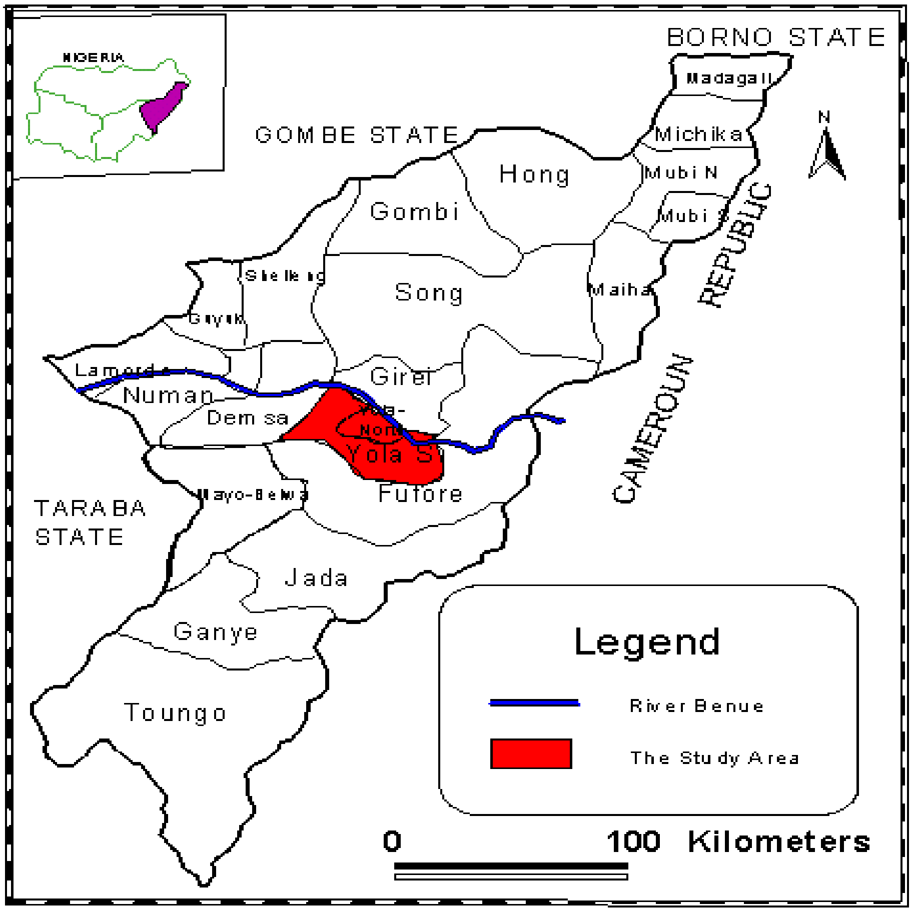

Figure 1: Map of Adamawa State showing the Study Area

METHOD

This study depends largely on personal field observations and literature review. In this study, the word "appropriate" is applied to describe what can be accessed, afforded, and sustained. Any technology that is without any of these three qualities is not appropriate. Similarly, the word "technology" is considered in a broad sense. It involves supporting machinery for sewage treatment, sewerage network, power generation, etc. The work also places emphasis on adoptive research to arrive at appropriate technology for all aspects of sewage treatment. Adoptive is , in simple terms, experimental research that assists one to apply technologies, inputs, recommendations, systems, or practises more appropriate in sewage treatment plant in particular location. A number of aspects of sewage management need adoptive research of one type or the other for adequate sewage management. For instance, in sewage management, the following aspects can be researched:(a) Water Quality of Sewage Drains (b) Physco-Chemical Characteristics of River water (c) Background Level of Trace-metals in River sediments, etc. These aspects and others are researched and the outcomes will guide which level of technology to select and implement.

Sewage Disposal Methods in Yola: As reported by Saidu (2012), majority (66.12%) of the residents in the study area dispose off their untreated sewage in open drainage channels mainly owing to poorly constructed and maintained drains that are inadequate for excessive sewage particularly from kitchens, bathrooms, toilets, etc. This finding was corroborated by all the staff respondents from the Adamawa State Ministry of Environment. Further more 21.01% of the residents disposed off their raw sewage on the land surface; 9.24% of the residents in toilets, while about 4% of them get the sewage disposed directly into surface water and groundwater sources as well as into soakaway. Clearly, all the disposal, methods are essentially inappropriate as they lack modern technologies.

Field Determination of Some Sewage Parameters in Yola: The specific parameters that were measured at the sampling sites were hardness, colour, phosphorus, and biochemical oxygen demand. Others were temperature, electrical conductivity, total dissolved solids, pH, and dissolved oxygen. The temperature, pH value, colour, electrical conductivity, total dissolved solids of the samples were determined in the field using the Hanna HI991300 portable pH/EC/TDS/Temperature meter. On the other hand, dissolved oxygen concentration was measured in the field using the Hanna HI9142 portable water proof dissolved oxygen meter equipment. Distilled water was used to cleanse the equipment after each sampling to eliminate impurity and interference. As for the values of biochemical oxygen demand, phosphorus, total hardness, and colour, Hanna C213 was used for determining them in the field (Saidu,2012).

Physical and Chemical Characteristics of Sewage in Yola: Results obtained from physical and chemical field analysis for colour, pH, temperature, dissolved oxygen (DO), electrical conductivity (EC), total dissolved solids (TDS), biochemical oxygen demand (BOD), and total hardness, in sewage in open drains in the area under consideration are presented on table 1. Of significant note, is that the appearance and colour of most of the samples is dark, measuring 86Hz (Hazen units) at Runde ward. It is worth noting that the catchments with dark sewage which could be related to discharge of excreta from bucket latrines and pit latrines are densely populated, while catchments with a clearer appearance are sparsely populated. The results on the table show that high and medium density areas reveal higher values for electrical conductivity (indicating high salt contents of sewage samples), total dissolved Solids, total hardness and colour. Also, indicated on table 1 are the pH value levels of 9.9, 10.5 and 10.8 for Demsawo, Runde and Luggere wards, respectively. These levels are outside the World Health Organizations, (WHO) permissible value range of 6-9 and signify the presence of contamination, particularly, from mineral acids and alkalines (Ademoroti, 1996). The result shows that the sewage samples from all catchments registered strong alkaline reactions with the exception of Makama and Jambutu area, only. Similarly, low amounts of dissolved oxygen (DO) in the sewage samples, ranging from the value of 4.04 mg/l in Makama ward to -2.15 mg/L in Runde wards, particularly in the sewage from the drains I Runde ward indicate an excessive load of organic waste, capable of having adverse effects on fish and other aquatic life. Such low levels are related to low pH values according to Oguagbuaja and Madu (1993).

The mean total dissolved solids (1016) mg/L to 1288mg/1) and electrical conductivity concentration levels (2,039 Scm^1 to 1569 Scm^1) are excessive for irrigation (Essiet and Ajayi, 2000). However, a significant relationship can be observed between the high temperature and the high concentrations of these variables in the sewage samples anlysed. This is because chemical activity is generally raised up by higher temperatures. As for the dissolved oxygen levels, high temperatures instead reduce its levels. In summary, the results on table 1 show that high density areas reveal high concentrations, or values for biochemical oxygen demand, total dissolved solids, total hardness, electrical conductivity, pH, phosphorus and temperature but low values for dissolved oxygen (DO). This suggests oxygen depletion arising from the mixture of the sewage with the rivers which can bed harmful to aquatic life (CEMP, 2002). Also, the documented negative health effects for people (in the table) could be adduced to high loadings of the elements in the sewage in the area

Table 1: Physical and Chemical Characteristics of Sewage in Open Drains in Yola

Parameter	Luggere	Runde	Demsawo	Makama	Karewa	Jambutu	WHO Standard value
Appearance	Dark	Dark	Dark	Clear	Clear	Dark	-
Colour (Hz)	78	86	73	66	70	71	50
Biochemical oxygen Demand mg/1	65	61	53	4.2	2.2	7.3	200
Electrical Conductivity (scm^1)	2,039	1,502.13	1,569.88	456.8	2,039	949	-
Total Dissolved Solids (mg/1)	179	1016	754.7	250.7	1,288	476.8	500
Phosphorus (mg/1)	53	22	34	28.3	2.35	26.7	-
Total hardness (mg/1 $CaCO_3$)	57	75	59	43	36	68	500
pH	10.8	10.5	9.9	8.00	7.75	5.9	6-9
Dissolved Oxygen (PPM)	1.79	2.15	1.5	4.04	1.4	3.98	-
Temperature at ^oC collection of samples	23.3	21.15	20.0	32.9	28.4	26.0	None

Source: Saidu, I. (2012).

Proposed Technology for Treatment of Sewage in Yola

There is need to construct and maintain sewage treatment plants and provision of skilled operator to handle sewage treatment as in the accompanying Fig 2. Sewage treatment occurs at specifically designed plants that receive municipal sewage from homes, businesses and industrial sites. The raw sewage is conveyed to the plant via a network of sewage pipes. After treatment, the sewage is discharged into the waterbodies, (rivers, lakes, or oceans), or in some few cases may be used for another purpose, such as irrigation of crops. Sewage treatment methods are usually categorized into Primary Treatment, Secondary Treatment, and Advanced Treatment. Diagrammatically, a sewage treatment plant is presented in a simplified form as in Figure 2 and preceding its description as follows:

(i) Primary treatment systems are meant to remove a large proportion of the suspended solids (SS), and associated Biochemistry oxygen demand (BOD). Raw sewage enters the plant from the municipal sewers-line and is first channeled through large mesh screens to remove large floating materials as wood, wire and rags. It is then run via channels at a controlled velocity so that sand, small stones and grit are removed and disposed of. The sewage then enters the primary sedimentation tank about 3m deep where particulate matter settles out to form sludge. Sometimes chemicals are used to aid the settling process. The sludge is removed and conveyed to the digester for further processing. Primary treatment removes nearly 30% to 40% of the pollutants volume from the sewage, mainly in the form of suspended solid and organic matter.

(ii) Secondary treatment reduces by 85 to 95 % to Biochemical Oxygen demand (BOD_5) and suspended solids (SS) and activates 90 to 99% of the fecal coliform bacteria. Of the several methods of secondary treatment, activated sludge is what is described here. The sewage from the primary sedimentation tank enters the aeration tank (Fig.2) where the sewage is mixed with air (Pumped in) and some of the sludge from the final sedimentation tank which contains aerobic (an Oxygen-rich environment) bacteria that breakdown organic material (pollutants) in the waste. After several hours, the sewage enters the final sedimentation tank, where sludge settles out. Some of this activated sludge rich in bacteria is recycled and mixed again in the aeration tank with air and new incoming sewage repeating the process. The bacteria are used again and again. Most of the sludge from the final sedimentation tank, however, is transported, or moved into sludge digester. There, along with sludge from the primary sedimentation tank, is treated by anaerobic bacteria which further degrade the sludge by microbial digestion.

(iii) Advanced sewage treatment process applies a mechanical, or a sand filtration technique to provide a similar but more thorough treatment than secondary processes. Primary and Secondary treatments do not remove all pollutants from the incoming sewage. More pollutants can be removed by adding another level of treatment similar to secondary treatment. Removal of nutrients such as phosphate, organic chemicals, or heavy metals, need treatments designed specifically for those contaminants. Treatment could include sand filters, carbon filters, or the application of chemicals that assist in the removal process.

Advanced treatment may remove more than 95% of the pollutants in the sewage. The treated sewage is then discharged into surface water, or could be used for irrigation of agricultural lands, or municipal properties, such as city parks gold courses, or grounds surrounding the sewage treatment plants. Advanced sewage treatment is used when it is particularly important to maintain good water quality.

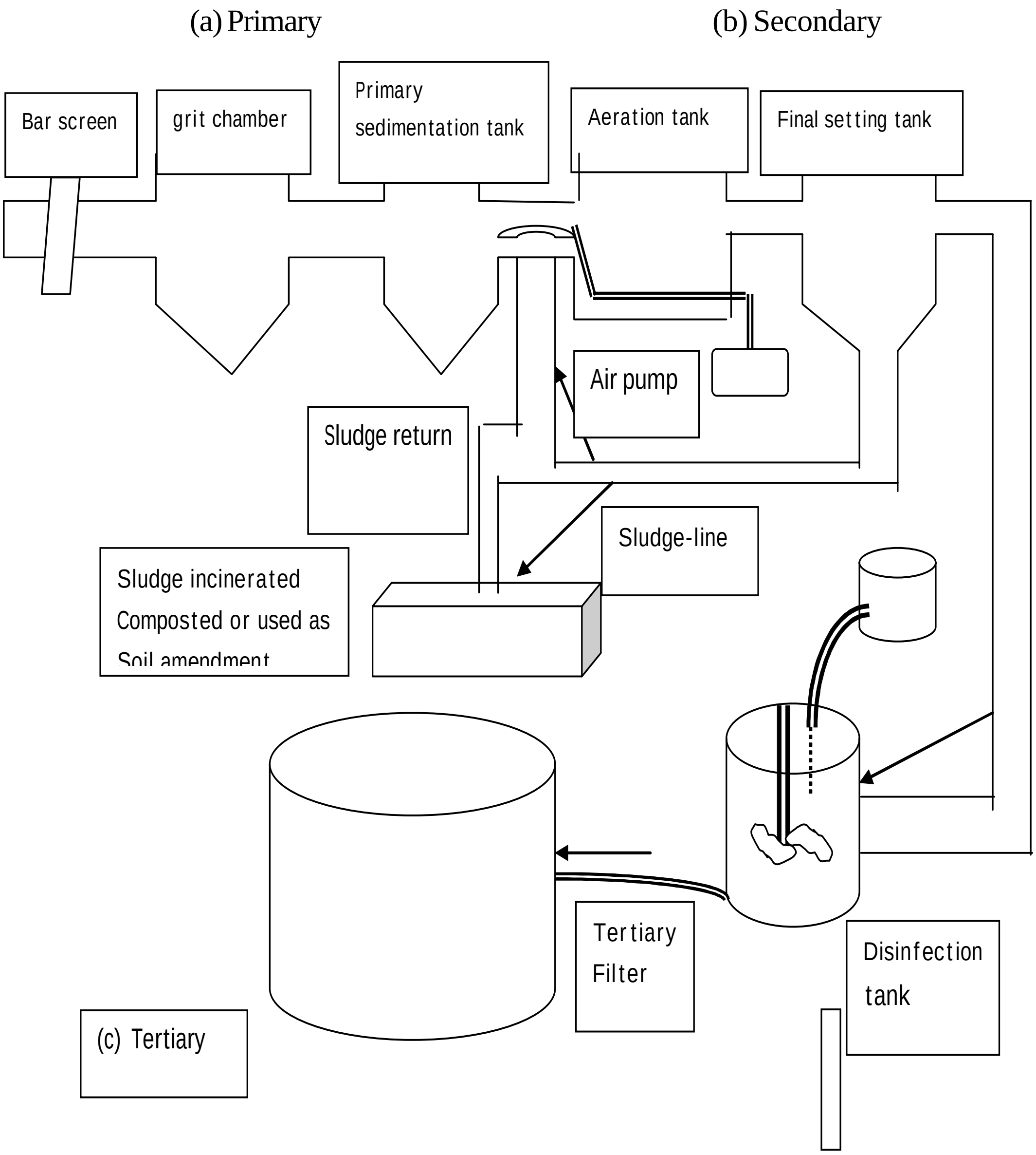

Fig. 2: Municipal Sewage Treatment Plant
Source: Adopted from Cunningham, W., P and Cunningham M.A, 2004

CONCLUSION AND RECOMMENDATIONS

It can be concluded from the foregoing that there is no sewage treatment plant in the study area, hence the prevalence of sewage related environmental pollution concern. Sewage treatment is essential and needs great and urgent attention from all environmental stakeholders as the current practice of handling same has become a source of concern to all. In view of the foregoing, the following recommendations are put forward:

i A joint venture between a foreign firm with a new technology to sell and a local firm wanting to use that technology is necessary. This could involve the foreign firm bringing in its technology to assist the local firm solve the problem of sewage treatment. In such circumstances, the technology is truly transferred so that the local operations and managers can take over the operations and master the technology themselves.

ii Privatizing the sewage management would remove the conflict of interest that exists between the State government which is to finance and regulate sewage treatment works and the local or municipal governments which are to operate them while the private sector runs and operates the sewage management, the State government could regulate and enforce the enabling law.

iii The three tiers of government should utilize improved technology, implement better, stricter regulations and enforcement, and introduce incentives to encourage citizens and corporations to restore and preserve waterways in the study area.

iv The Adamawa State Environmental Protection (Effluent Limitation) Regulations 1991 which makes it compulsory for industries to install anti-pollution equipment for treatment of effluents and chemical discharges be implemented and complied with by organizations, industries and communities.

v The study area needs to adopt strong enforcement policy dealing with pure control and discharges "polluters pay" principle, where every body contributing to pollution pays for the clean-up costs.

vi For the study area, municipal governments need to implement effective water/ waste/effluent pricing reforms based on volume full water metering. Only when residential, commercial, and industrial consumers realize the true costs of their water use and wastewater generation will they have a financial incentive to minimize their use of water.

vii There is need for privatization and regulation of waste water utilities.This may bring an end to the conflict of interest where the State government finances, regulates and proscutes.

viii Introduction of incentives in handling of sewage is crucial. The three tiers of government should utilize improved technology, implement better stricter regulations and enforcement and introduce incentives to encourage citizens and corporations to reserve and preserve Yola to waterways.

ix A regulation for effluent quality to be in place and to be implemented making it clear that if caught effluent polluters will have to pay penalties for breaching the regulation.

x Improved technology has to be designed to preserve the diversity and productivity of ecosystems to minimize public health hazards and to permit desired uses of lakes and rivers. Tertiary treatment with disinfection can achieve these ends.

xi Efforts at ensuring better source control of pollution be made. Dealing with pollution at its source carries more effective and less expensive cost than attempts to remove toxins at treatment, or to rehabilitate damaged ecosystems. The private sector and the government ought to develop technological and regulatory methods, respectively, preventing industrial pollutants from entering the sewage system.

Comprehensive monitoring of effluents is desirable. Monitoring is an integral part of a source control programme. Periodically monitoring effluents would help businesses, institutions and industries in each community to be aware of the happenings within their environment. Stricter monitoring of industrial sewer polluters have to be also put in place. Sampling teams hired to spot check industries and /or intelligent electronic sampling devices located in sewers would validate the results submitted by industries. Essentially, public education and outreach on the adoption and development of technological processes for improving the present situation in the study area is crucial.

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