**CRITICAL APPRAISAL OF WASTEWATER MANAGEMENT IN NIGERIA**

**BY**

**AGBEDE GOODNESS YERINMINI**

**MATRIC NO: 15/ENG03/003**



**SUBMITTED IN PARTIAL FULFILMENT**

**OF THE REQUIREMENT FOR THE AWARD OF THE**

**BACHELOR OF ENGINEEERING (B.ENG) DEGREE IN CIVIL ENGINEERING**

**TO**

**ENGR. OYEBODE O. J.**

**DEPARTMENT OF CIVIL ENGINEERING, COLLEGE OF ENGINEERING, AFE BABALOLA UNIVERSITY, ADO-EKITI,**

 **NIGERIA**

**APRIL, 2020**

# ABSTRACT

Domestic wastewater can be viewed as an important resource when properly managed; it requires adequate management practice aiming at efficient treatment and distribution for reuse. Treated domestic wastewater reuse with acceptable quality plays a crucial role as an additional water source considering groundwater protection and conservation. The main objective of this study was to investigate treatment and reuse of domestic wastewater, as well as the wiliness and awareness of the public on domestic wastewater treatment, personal reuse and for other purposes such as irrigation.

The need to certify adequate provision of potable water over the years to Nigerians in rural, semi- urban and urban communities had been a challenge in spite of the abundance of water resources. It was observed that most water borne diseases or outbreaks that have occurred in the recent year were caused by the inadequate control of treatment facilities, contamination of untreated supplies, storage tanks, distribution system, interrupted treatment and ceasing attention to maintenance and operating details. Nigeria as a signatory to Millennium Development Goals(MDGs) of recent therefore embarked on the construction of dams and modern water treatment plants towards provision for people access to improved sources of drinking water. The methods and processes in modern conventional wastewater treatment plants as its being characterized by a degree of mechanization and automation which requires the engagement of high skill personnel are explained extensively in the paper. The paper also highlights the challenges of modern conventional wastewater treatment which lies in the maintenances of electrical/mechanical equipment and other operational facilities, manpower development, power supply, security, political will and continuity etc.

# 1.0 INTRODUCTION

At a time when Sustainable Development Goals are a central issue, integrating effective, efficient and eco-friendly wastewater management practice into the life cycle and operation of the urban system would be a step towards achieving Sustainable Development Goal which will ensure a healthier environment for everyone. Food and water are vital and important for Nigeria and the world, not excluding disease prevention. Wastewater management can and have proven to be a reliable and a veritable tool for achieving sustainable development, by serving as a means of pollution prevention, source of alternative water for non-potable uses and disease prevention.

In developing countries, lack of sufficient funds, high treatment costs of the conventional treatment systems and rapid increases in wastewater volumes that exceed the current capacities of the treatment plants, results in a poor percentage of wastewater undergoing primary/secondary treatment. The farmers whose lands are along these water bodies often channel the partially treated or un-treated wastewater that is released into the rivers and lakes for irrigation. Though in the short run this water provides a reliable source of irrigation and income for these farmers, in the long run, it has adverse effects on the farmers’ health, soil and also pollutes the groundwater thereby making Any water that has been adversely affected in quality due to human activities can be regarded as wastewater (Burton and Stensel, 2003). It includes domestic liquid waste from residences, industries or agriculture. It encompasses a wide range of contaminants which can be potentially harmful or concentrations that can lead to degradation in water quality. These potential contaminants include soaps and detergents from bathrooms, food scraps and oil from kitchens and other human activities that involve the use of water. Potable water becomes wastewater after getting contaminated with all or some of the above mentioned potential contaminants.

Wastewater that comes from human waste (feaces, urine or other body fluids), also known as Blackwater, includes water from lavatories, septic tanks or soak away, and washing water; while greywater is wastewater that comes from urban rainfall runoff from roads, roofs, and sidewalks. Wastewater can be contaminated with different components which mostly include pathogens, synthetic chemicals, organic matter, nutrients, organic compounds and heavy metals. These occur either in solutions or as particulate matter.

If wastewater is not properly managed it could become a point source of pollution which could be a hazard for the health of human populations and the environment. The environmental impact of wastewater degradation may result in physical changes to receiving waters, increased level of dissolved oxygen, bioaccumulation in aquatic life, release of toxic substances and increased ground water quality (Mahmood and Maqbool, 2006). Diseases caused by bacteria, viruses and protozoa are the most common health hazards associated with untreated wastewater. Many microbial pathogens in wastewater can cause chronic diseases with long-term effects such as degenerative heart disease and stomach ulcer (Paillard et al., 2005). These debilitating ailments can be fatal and have been known to impair human productivity. Wastewater also consists of vast quantities of bacteria, most of which are harmless to man. However, pathogenic forms that causes diseases such as typhoid, dysentery and other intestinal disorder may be present in the wastewater (Absar, 2005).

Urban growth impacts on infrastructure in developing countries are extremely pressing. In many cities of Asia, Africa and Latin America, engineered sewage collection systems and wastewater treatment facilities are often non-existent. For developing countries, particularly in arid areas, wastewater is simply too valuable to waste. It contains scarce water and valuable plant nutrients, and crop yields are higher when crops are irrigated with wastewater than with freshwater. Farmers use untreated wastewater out of necessity and, unfortunately, it is a reality that cannot be denied or effectively banned (Looker, 1998).

Wastewater is a complex resource that is both advantageous and inconveniencing in its use. It is a renewable resource that once used can be reclaimed and used again for different beneficial uses. The quality of the once used wastewater and the specific type of reuse determine the level of subsequent treatment needed. The reclaimed wastewater can be used for purposes, other than drinking, such as; irrigation of public parks, athletic fields, recreation centers, school yards and playing fields, reservations of highways, irrigation of landscaped area surrounding buildings, fire protection, as well as toilet and urinal flushing in public buildings (Hespanhol, 1992). This will greatly reduce the overstretching of potable water. The lack of freshwater resources large enough to meet the demand of a burgeoning population led to the emergence of wastewater reclamation and reuse as components of wastewater management (Asano et al., 1998). Water conflicts arise mostly as a result of the need to manage the resource which is becoming scarcer with time. Benefits of water reclamation and reuse are recognized as a method of preventing the pollution of surface and ground waters (Hespanhol, 1992).

Even though wastewater and its nutrient contents can be used for crop production, thus providing significant benefits to the farming communities and society in general, its use could however also impose negative impacts on communities and on ecosystems. The use of wastewater containing toxic wastes coupled with the lack of adequate finances for treatment is likely to cause an increase in the incidence of water borne diseases as well as more rapid environmental degradation. Although the harmful effects of using contaminated wastewater effluents could go undetected for several years, it however adversely affects groundwater quality when nutrients leach down the soil into the groundwater system (Mahmood and Maqbool, 2006). Near surface aquifers in intensely irrigated areas using wastewater can indeed become polluted, thus reducing the aquifer portability.

##  Literature review

**1.1 Wastewater Management System**

Domestic wastewater management system is a wastewater system that processes wastewater from a home, or group of homes Elango (2000).Wastewater management is the collection, transport, [processing, r](http://en.wikipedia.org/wiki/Waste_treatment)ecycling or disposal of waste materials. Mekala, Davidson, Samad, and Boland (2008) described wastewater management system to include a network used to bring wastewater to treatment plant. The system also includes the source of wastewater in the home, technologies for treating the wastewater, and technologies and processes for returning the processed wastewater to the environment.

Domestic wastewater management involves the determination of domestic wastewater (source), its threat to the environment, collection systems, treatment and reuse. An improperly managed domestic wastewater has the potential to negatively impact on the natural environment, on human health as domestic wastewater contains disease producing microorganism and chemicals and on the economic environment

### 1.2 Water Treatment

Water treatment involves process that alter the chemical composition or natural “behavior of water”. Primary water availability include surface or ground water. Most municipal or public water comes from surface water while private water supplies usually consists of ground water pumped from wells or boreholes.

### 1.3 Water Quality

The treatment of water in order to make it suitable for drinking, domestic or industrial use includes a complex of physical, chemical and biological methods which change the initial composition of water. Water treatment involves not only purification and removal of various unwanted and harmful impurities, but also improvement of the natural properties of water by adding certain deficient ingredients.

### 1.4 Water Quality Parameters

Water quality parameters based on present-day standards and guides are presented to assist in the establishment of water system performance goals for any plant. Quality parameters are expected to change as new information on the nature and behavior of water is revealed. The trend is toward production of water of higher quality.

The substances in Nigeria standards for drinking water quality are simply divided into physical/organoleptic, chemical organic and inorganic constituents, disinfectants and disinfectants by-products, radionuclide and microbiological parameters.

## 1.5 Domestic Wastewater Treatment Methods

The aim of treatment is to reduce the level of pollutants in the wastewater before reuse or disposal into the environment (UN Water, 2014). The standard of treatment required for domestic wastewater is usually location and use-specific. There are different wastewater treatment methods available, these methods can be simply grouped as aerobic (biological), anaerobic (biological) and physico-chemical processes.

**Aerobic Treatment of Wastewater**

In aerobic wastewater treatment systems, aerobic organisms in the presence of oxygen convert organics in the wastewater into carbon dioxide and new biomass. Oklahoma Department of Environmental Quality in explaining aerobic treatment puts it as the use of air to treat wastewater. Treatment of the wastewater occurs in the aeration chamber. Air is bubbled through the wastewater allowing the natural bacteria to flourish. These bacteria feed on and breakdown the organic material found in the wastewater. The wastewater then flows to the clarifier where the solids are separated from the liquids. In a similar explanation, Gustafson, Anderson, and Christopherson (2001) said aerobic treatment pre-treats wastewater by adding air to break down organic matter, reduce pathogens, and transform nutrients. Compared to conventional septic tanks, aerobic treatment breaks down organic matter more efficiently, achieve quicker decomposition of organic solids, and reduce the concentration of pathogens in the wastewater.

**Anaerobic Treatment of Wastewater**

Wright (2008) and Jhansi and Mishra (2013) described anaerobic method of treatment as a process where anaerobic bacteria degrade organic materials in the absence of oxygen and produce methane and carbon dioxide. The produced methane can be reused as an alternative energy source (biogas). Anaerobic wastewater treatment differs from conventional aerobic treatment. The absence of oxygen leads to controlled conversion of complex organic pollutants, mainly to carbon dioxide and methane. Anaerobic treatment has favorable effects like removal of higher organic loading, low sludge production, high pathogen removal, biogas production and low energy consumption (Mrowiec and Suschka, 2009).

**Physico-Chemical Treatment of Wastewater**

Physicochemical wastewater treatment is a frequently used technique in the area of wastewater treatment. Physicochemical wastewater treatment techniques are applied for the removal of heavy metals, oils and greases, suspended matter and dissolved organic substances, organic and inorganic components, difficult to decompose, toxic pollutants or high salt concentrations, phosphorus and so on. The physicochemical wastewater treatment techniques are used as pre-treatment, final treatment as well as specific treatment for wastewater reuse as process water. Dhameja (2006) included dilution, sedimentation and filtration as being part of the physical processes. According to Cruden (2015) Physicochemical treatment of wastewater focuses primarily on the separation of colloidal particles. This is achieved through the addition of chemicals (called coagulants and flocculants). This changes the physical state of the colloids allowing them to remain in an indefinitely stable form and therefore form into particles or flocs with settling properties. In addition to the processes stated by Dhameja (2006), Cruden (2015) further added coagulation (rapid mixing) and flocculation as physico-chemical process.

### Domestic Wastewater Treatment Stages

The aim of domestic wastewater treatment is the removal of contaminants from the water which is either reused or discharged into the environment without fear of causing long or short term environmental degradation. The wastewater treatment process is carried out in three stages. Dhameja (2006), Sincero and Sincero (2008), and Evanylo (2009) put the three stages of domestic wastewater treatment as: Primary treatment, Secondary treatment and Tertiary treatment.

**Primary Treatment of Domestic Wastewater**

Primary treatment involves the removal of a portion of the suspended solids and organic matter from the wastewater. Wastewater contains a wide variety of solids of various shapes, sizes and densities (Dhameja, 2006). The purpose of primary treatment is the removal of the suspended solids, scum, grit, oil and grease, the removal is done by use of bar screens, skimming tanks, grit chamber, and floatation/sedimentation unit respectively. Sincero and Sincero (2008) noted that preliminary treatment also constitutes part of the primary treatment.

**Secondary Treatment of Domestic Wastewater**

According to Dhameja (2006), secondary treatment involves removing, stabilizing, and rendering harmless very fine suspended matter. Sincero and Sincero (2008) added that secondary treatment involves removing leftovers from the primary treatment. These leftovers are composed of colloidal and dissolved organic matters which cannot be removed in the primary treatment stage. Asano *et al.* (1985), Dhameja (2006), Sincero and Sincero (2008), and Jhansi & Mishra (2013) have all highlighted various methods for achieving secondary treatment to include:

* Constructed wetland
* Activated sludge system
* Aerobic granulation
* Aerated lagoon
* Rotating biological contactor
* Membrane bioreactor
* Sequencing batch reactor
* Trickling filter
* Bio-towers

 **Tertiary Treatment of Domestic Wastewater**

Tertiary treatment which is also called advanced wastewater treatment is required when reclaimed water is to be put to direct use, (Dhameja, 2006). Tertiary treatment is initiated after secondary treatment for further purification and decontamination. The goal of tertiary treatment is to reduce unwanted elements such as Suspended Solids, Chemical Oxygen Demand (COD) (solid and colloidal), Biological Oxygen Demand (BOD), phosphorus and specific compounds (pesticides, metals, detergents, and so on), this is in accordance with Dhameja (2006). Kamyotra and Bhardwaj (2011) further explained that tertiary wastewater treatment is employed when specific wastewater constituents which cannot be removed by secondary treatment must be removed. The treatment processes are necessary to remove nitrogen, phosphorus, additional suspended solids, refractory organics, heavy metals, and dissolved solids. It is designed to improve the quality of purified water so that it can be discharged into the natural environment or re-used.

**1.6 Uses of Treated Wastewater**

Wastewater can be recycled/reused as a source of water for a multitude of water-demanding activities such as agriculture, aquifer recharge, aquaculture, firefighting, flushing of toilets, snow melting, industrial cooling, parks and golf course watering, formation of wetlands for wildlife habitats, recreational impoundments, and essentially for several other non-potable requirements.

**1.7 Advantages of Wastewater Treatment and Reuse**

According to Academic Research paper writing services (May 20, 2015.) Wastewater recycling can be categorized and viewed from three perspectives of: environmental benefits, social benefits and economic benefits.

**Environmental Benefits**: Reuse of wastewater can be a supplementary source to existing water sources, especially in arid/semi-arid climatic regions (Vigneswaran and Sundaravadivel, 2004). Through provision of extra water source, the practice of water recycling helps in discovering methods of reducing diversion of water from sensitive ecosystems. Fish, plant and wildlife what’s more, depend on sufficient flow of water in their ecosystem to live and reproduce (Academic Research paper writing services, May 20, 2015). Therefore, recycling provides adequate supply of water to prevent water resource diversion for urban, industrial and agricultural use, which can easily deteriorate water quality and health of a given ecosystem. Jhansi and Mishra (2013) Benefits of safely recovering and reusing human wastes include the reduction in effluents to bodies of water and the opportunity to re-build soil with valuable organic matter. The recycling process also helps in eliminating discharge of waste water to the ecosystem while preventing pollution. The recycled wastewater can be used to enhance or create wetlands habitat and enhance breeding grounds of fisheries. Not forgetting its capacity to recharge ground water. Reuse of wastewater can be a supplementary source to existing water sources, especially in arid/semiarid climatic regions.

**Social Benefits**: Reused water meets the needs of majority of human use as well as domestic applications (drinking water). The water must nevertheless be recycled properly to gain its benefit. The recycled water can be used to maintain public parks and gardens, golf courses and other recreational centers meant for social activities and gathering for fun seekers.

**Economic Benefits**: Since recycled water is often used for irrigation purposes, it benefits different economies because they use the water to enhance their agricultural sector through increased crop production in and out of wet season and in areas affected by water scarcity, additionally can serve for cooling purposes in industries, can also be used in paper mills, concrete block making industries and so on (Academic Research paper writing services, May 20, 2015, UN Water, 2014). Industries are very vital for economic growth of any country even as Nigeria is industrializing. UN Habitat (2010) expressed that smart and sustained investment in wastewater management will generate multiple dividends in society, the economy and the environment. It can involve private and public sectors, fulfilling public needs as well as social equity and enhance food security.

### 1.8 Wastewater characteristics

The effective management of any wastewater flow requires an accurate knowledge of its characteristics. These characteristics, according to Burks and Minnis, 1994, are necessary to facilitate the effective design of wastewater treatment and disposal system, and also to enable the development and application of water conservation and waste load reduction strategies. The quality of wastewater may be defined by its physical, chemical and biological characteristics. Physical parameters include; temperature, pH, electrical conductivity, colour, odour, and turbidity. Insoluble contents such as oil and grease, solids (suspended or dissolved) and inorganic fractions also fall into this category (Burks and Minnis, 1994).

Chemical parameters associated with the organic content of domestic wastewater include Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD), Total Organic Carbon (TOC) and Total Oxygen Demand (TOD). Inorganic chemical parameter include alkalinity, salinity, hardness, acidity as well as concentrations of cations such as Manganese, Iron and anions such as sulfates, chlorides, nitrates and phosphates. Bacteriological parameters include fecal coliforms, coliforms, algae, protozoa’s, specific pathogens and viruses (Metcalf and Eddy, 2003).

Management of wastewater involves identifying the source and type of wastewater, ways in which it can be harnessed for potential reuse and ways in which the potential risk posed by wastewater can be eliminated or reduced. Major challenges faced by wastewater management include infrastructure, pollution of water bodies, choice of appropriate technology, sludge production and reuse.

# Conclusion

As a result of the volume of wastewater generated in the country and the challenges posed to the environment and to the inhabitants, coupled with the fairly good physico-chemical composition, this wastewater can be reused for other purposes. The benefits of collecting wastewater in the country are numerous; the collected wastewater could be recycled for all domestic activities except cooking and drinking which fortunately accounts for only 4% of water usage in the study area. Wastewater re-use involves passing the wastewater through a treatment system, which involves the removal of solids, inorganic and organic compounds, bacteria and algae and subsequent conversion into economically acceptable water. Wastewater re-use in the country will allow effluents to be disposed of without danger to human health or unacceptable damage to the natural environment.

It is therefore highly recommended that domestic wastewater re-use be adopted as a disaster risk reduction strategy for urbanized areas in developing countries like Nigeria.

The treated water can thus be safely used for the following purposes;

1. Fire Protection. This can be achieved through running a series of pipes into the area and installing fire hydrants. A short lateral line will be designed to connect each fire hydrant to a distribution main. Shutoff valves will be located at strategic points throughout the system to provide control of any section or service outlet, including hydrants. These valves will serve the purpose of isolating the system for required maintenance and to ensure that a main break affects only a small section.
2. Irrigation and fish farming. As a result of the prevailing climatic conditions in the area, two seasons are clearly identifiable; a seven months of rainy season and five months of dry season. During the dry season water becomes very scarce and the food security of the area and even the country becomes challenged. Treated wastewater can effectively be harnessed for irrigating farmland for dry season production of crops and vegetables. These can be grown at local levels for households or community cooperative bodies with little parcels of land for cultivation. This will go a long way in creating employment, maintaining the environment and boosting the food requirement of the country. This can readily be achieved by piping the treated water to the farm through the series of mains and other distribution network. Fish farmers have to struggle to get water for the farm from wells and boreholes since treated water, especially the one that has undergone both secondary and tertiary treatment has an adverse effect on the fish, and wastewater that has undergone primary treatment only can be used comfortably for this purpose without having any adverse effect on the fish.
3. Aquifer Recharge. An aquifer is a subsurface reservoir that transmits water to wells and boreholes. Hand dug wells and boreholes obtain their water from underground reservoirs which in turn get their water from rainfall through infiltration into the ground. However, groundwater recharge is limited by so many factors chiefly of which is climatic, rainfall, and geology. During the long dry season this reservoir becomes depleted as a result of pressure from overuse. This vital resource can be recharged artificially. The main purpose of artificial aquifer recharge technology is to store excess water for later use. The method will ensure that groundwater levels are maintained while improving the water quality of the wastewater as it undergoes natural treatment before joining the groundwater system.

# Recommendation

It is therefore expedient that necessary steps be taken by developing countries like Nigeria by using the most appropriate technology for wastewater management. Considerations should be made to the Environmental, Social and Economic benefits of the technology and method to be used. There is no doubt that Nigeria has little or nothing to show in wastewater management and recycling. This has been proven by the investigation of Adesogan (2013) who made an inventory of domestic wastewater treatment plants across Nigeria.

Elika (2013) believes that Nigerian cities can achieve centralized wastewater management through proper Government policies, public-private sector partnership investment and could succeed in turning wastewater to potable water as many developed nations have done. This research therefore suggests that centralized treatment of domestic wastewater in Nigeria should be initiated in the light of sustainable development. This can be achieved by the government or through public private partnership. Wise investments in wastewater management will generate significant returns, as addressing wastewater is a key step in reducing poverty and sustaining ecosystem services. Instead of being a source of problem, well-managed wastewater will be a positive addition to the environment which in turn will lead to improved food security, health and functioning of the bio-system. The sludge from the treatment process can and should be utilized in improving agriculture in the state. The reclaimed/recycled water can also be used for irrigation purposes and other non-potable uses like firefighting, Park watering and so on. Public enlightenment can also be organized to educate on the safety and use of properly treated domestic wastewater.

# References

Burton, F. and Stense, H. (2003), “Wastewater Engineering, Treatment and Reuse, 4th edition”, McGraw Hill, New York, USA.

Mahmood, S. and Maqbool, A. (2006), “Impacts of Wastewater Irrigation on Water Quality and on the Health of Local Community in Faisalabad, Pakistan”, Pakistan Journal of Water Resources, 10: pp. 230-270.

Paillard, D., Dubois, V., Thiebaut, R., Nathier, F., Hogland, E., Caumette, P. and Quentine, C. (2005), “Occurrence of Listeria spp. In effluents of French urban wastewater treatment plants”, Journal of Applied Environmental Microbiology, Vol. 71 No. 11, pp. 7562-7566.

Absar, A.K. (2006), “Water and Wastewater Properties and Characteristics”, John Wiley and Sons, Inc., New Jersey.

Hespanhol, I. (1992), “Wastewater as a resource for beneficial use in Brazil”, International Reference Center on Water Reuse-IRCWR, University of São Paulo, Brazil.

Elango, S.S (2000). Urban Water Management (Final Thesis). Atlantic International University. Retrievedfrom: <http://aiu.edu/publications/student/english/Urban%20Water%20Management.html>

Mekala, G.D., Davidson, B., Samad M., and Boland, A.M. (2008). A Framework for Efficient Wastewater Treatment and Recycling Systems. Colombo, Sri Lanka: International Water Management Institute. (IWMI Working Paper 129

Asano, T. (1998), “Wastewater Reclamation and Reuse”, CRC Press, Boca Raton, Florida.

Burks, B.D. and Minnis, M.M. (1994), “Onsite Wastewater Treatment Systems”, Madison, WI: Hogarth House,

Ltd.

Dhameja, S.K. (2006). Environmental studies (3rd Revised Edition). New Delhi, India: Katson Books.

Adesogan, S. (2013). Sewage technology in Nigeria: A pragmatic approach. Science Journal of Environmental Engineering Research. doi: 10.7237/sjeer/266. Retrieved from:

[http://www.sjpub.org/sjeer/sjeer-266.pdf.](http://www.sjpub.org/sjeer/sjeer-266.pdf)

Vigneswaran, S.,and Sundaravadivel, M. (2004), Recycle and reuse of domestic wastewater, in Wastewater Recycle, Reuse, and Reclamation, [Ed. Saravanamuthu (Vigi) Vigneswaran], in Encyclopaedia of Life Support Systems (EOLSS), Developed under the Auspices of the UNESCO, Eolss Publishers, Oxford ,UK, [http://www.eolss.net]