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DAHA SÜRDÜRÜLEBİLİR SANİTASYONA DOĞRU: KUMASİ METROPOLİS GANA ÖRNEK OLAY ÇALIŞMASI

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TOWARDS MORE SUSTAINABLE SANITATION: THE CASE STUDY OF KUMASI METROPOLITAN AREA, GHANA

(Master's Thesis)

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July 2017

KAYSERİ

COMPLIANCE OF SCIENTIFIC ETHICS

I hereby declare that all the information in this research study, “Towards more Sustainable Sanitation: The Case of Kumasi Metropolitan Area, Ghana”, is obtained in conformity with academic and ethical guidelines. I also declare that I have given references to all materials used in this study as required.

Ibrahim BASIRU

COMPLIANCE OF THESIS DIRECTIVES

I hereby declare that this study, **"Towards more Sustainable Sanitation: The Case of Kumasi Metropolitan Area, Ghana"**, is prepared in accordance with Erciyes University Graduate thesis proposal and thesis writing instructions.

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Prof. Dr. Mustafa DEMİRCİ danışmanlığında **Ibrahim BASIRU** tarafından hazırlanan **"Towards more Sustainable Sanitation: The Case of Kumasi Metropolitan Area, Ghana"** adlı bu çalışma jürimiz tarafından Erciyes Üniversitesi, Sosyal Bilimleri Enstitüsü Siyaset Bilimi ve Kamu Yönetimi Anabilim Dalında yüksek lisans tezi olarak Kabul edilmiştir.

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DAHA SÜRDÜRÜLEBİLİR SANİTASYONA DOĞRU: GANA KUMASİ METROPOLİS ÖRNEK OLAY ÇALIŞMASI

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ÖZET

Bu tezde sağlık, teknik, mali ve ekonomik ve çevre gibi bazı seçilen sürdürülebilir sanitasyon ölçütleri kullanılarak Gana Ashanti Bölgesi Kumasi Metropoliten Alanı'nda 2008-2015 arasında sanitasyon sistemindeki ilerlemeleri değerlendirme girişiminde bulunulmuştur. Çalışmada yetersiz sanitasyonla ilgili hastalıklar ve ölümlerin sayıları, su kaynakları üzerinde biyolojik oksijen talebi düzeyi, sanitasyon teknolojisinin sağlamlığı, Metropol'de sanitasyon yönetimi için tahsis edilen para miktarı ve ev tuvaleti inşa etme maliyeti gibi değişkenler ile ilgili veriler analitik olarak araştırılmıştır. Bu çalışma için veriler Güney Suntreso Devlet Hastanesi, Tafo Devlet Hastanesi, Kumasi Metropoliten Meslisi Atık Yönetimi Departmanı'ndan toplanmış ve betimsel istatistik yöntemler kullanılarak analiz edilmiştir. Çalışmada sürdürülebilirlik bakımından kentsel alanda sanitasyon sisteminde çok az ilerleme olduğunu öne sürülmüştür.

Anahtar kelimeler: Yetersiz sanitasyon ve hijyen, sürdürülebilir sanitasyon, sürdürülebilir sanitasyon kriterleri, sanitasyon sistemleri.

TOWARDS MORE SUSTAINABLE SANITATION: THE CASE STUDY OF KUMASI METROPOLITAN AREA, GHANA

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ABSTRACT

This thesis is an attempt to assess the improvements of sanitation system of Kumasi Metropolitan Area in the Ashanti Region of Ghana between 2008-2015, using some selected sustainable sanitation criteria; health, environment, technical, and financial and economic. The study critically investigates the data about variables such as the number of diseases and deaths associated with unsatisfactory sanitation, level of biological oxygen demand on water sources, robustness of sanitation technology, amount of money earmarked for management of sanitation within the metropolis as well as cost of building household latrines. Data for this study were obtained from South Suntreso Government Hospital, Tafo Government Hospital, Waste Management Department of Kumasi Metropolitan Assembly, WasteCare Associates, and were analyzed using primary descriptive statistical methods. The study suggests that there has been little improvement in the sanitation system within the urban area in terms of sustainability.

Key words: Inadequate Sanitation and Hygiene, Sustainable Sanitation, Sustainable Sanitation Criteria, Sanitation Systems.

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ACRONYMS

BOD	Biochemical/Biological Oxygen Demand
CONIWAS	Coalition of NGOs in Water and Sanitation
CWSA	Community Water and Sanitation Agency
ECOSAN	Ecological Sanitation
EHSD	Environmental Health and Sanitation Directorate
EPA	Environmental Protection Agency
GHC	New Ghana Cedis (Currency Unit)
GSS	Ghana Statistical Service
GWCL	Ghana Water Company Limited
KVIP	Kumasi Ventilated Improved Pits
MDGs	Millennium Development Goals
MEST	Ministry of Environment, Science, Technology and Innovation
MLGRD	Ministry of Local Government and Rural Development
MMDAs	Metropolitan, Municipal and District Assemblies
MWRWH	Ministry of Water Resources Works and Housing
NGOs	Non-Governmental Organizations
NSD	National Sanitation Day
PHC	Population and Housing Census
SuSanA	Sustainable Sanitation Alliance
UNICEF	United Nations Children's Emergency Fund
USAID	United States Agency for International Development
USD	United States Dollar
VIP	Ventilated Improved Pit
WHO	World Health Organization

WMD	Waste Management Department
WRC	Water Resources Commission
WSP	Water and Sanitation Program
WSSCC	Water Supply and Sanitation Collaborative Council
WSUP	Water and Sanitation for the Urban Poor

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INTRODUCTION

Research Problem

The subject matter of the study is sanitation system in Kumasi Metropolis, Ghana. The main aim of the study is an assessment of improvements of sanitation system within the Kumasi Metropolis, Ghana, from 2008 to 2015 in terms of sustainable sanitation. The research problem is poor sanitation in the Metropolis. In order to define the scope of the study, basic terms have been clarified below. These include, Kumasi Metropolis (Ghana), sanitation, sanitation system, sustainable sanitation and sustainable sanitation criteria.

The research area is Kumasi Metropolis, Ghana. The Kumasi Metropolis is the most populated area in the Ashanti Region. Amid the 2010 population census, the population of Kumasi was hovering around 2,035,064. Three years later, the number increased to around 2,396,458 based on a growth rate of 4.8 percent per annum (Kumasi Metropolitan Assembly, 2014, p.3). Kumasi has one of the biggest markets in West Africa, which draws many more daily. Resettlement accounts for much of Kumasi's growth in recent years, and there is a significant migrant community (Thrift, 2007, p.1). The research area will be explained in detail in chapter two.

The study deals with problem of poor sanitation in Kumasi. Access to sanitation remains a great challenge for the residents of Kumasi. Acheampong (2010, p.53-54) conducts a study on environmental sanitation management in Kumasi using six suburbs (Asokwa, Asafo, Ahodwo, Asawase Zongo, Kaase, Atasomanso) and Kumasi Central Business District (KCBD) as case study. He indicates that about 53 percent of those in the KCBD lack toilet facilities in the building. This compels them to join queue to gain access to it. The remainder, which is almost 47 percent shares a toilet of one seat for many shop holders. Inadequate availability of urinals and the time one is required to walk, to have access to one propels 53 percent of central business people urinate in a

container, especially women, and pour the urine into the open drain, causing the entire place to smell urine stench. This breed disease vector and can easily promote transmission of diseases if allowed to continue.

WSSCC and WHO (2005, p.VI) define sanitation as construction of facilities for instance latrines that improve the management of feces and urine. Similarly, sanitation in the words of Van Minh and Viet Hung (2011, p.64) refer to the provision of facilities and services for the disposal of human excreta in a safely way. Based on the above definitions, sanitation in this study is limited to toilets and management of human excreta. Provision of sanitation facility is needed not singularly to avoid diseases and promote general wellbeing, but to set the basis for human rights and sustainable development (UNICEF and USAID, 1997, p.2).

A sanitation system comprises the users of the system, the collection of waste, transport and treatment. It encompasses management of the final products of human excreta, waste water from industries, storm water as well as solid waste (Kvarnstrom and Petersens, 2004, p.2). The stages of sanitation system (user, collection, transport, and treatment) are critical to consider for an assessment of sanitation system as technologies vary in every single stage and every one of the processes assume a definite role in achieving improved sanitation (Gunawardana; Galagedara; Silva, 2011, p.144). Health protection is the underlying motive for developing good systems of sanitation. This is equally the underlying motive behind the development and rife use of the conventional flush and discharge sewage system (Drangert; Brew; Winblad, 1997, p.13). According to the Joint Monitoring Programme of United Nations Children's Education Fund and World Health Organization (UNICEF/WHO) (2013, p.12), improved sanitation is a facility that ensures that human excreta are hygienically separated from human contact.

The study intends to assess sanitation systems in Kumasi in terms of sustainable sanitation criteria. The concept of sustainable sanitation has a different meaning for different people. For this study, "*sustainable sanitation systems can be defined as those that protect and promote human health, do not contribute to environmental degradation or depletion of the resource base, are technically and institutionally appropriate, economically viable and socially acceptable. For sustainability, a more holistic decision-making process for sanitary provision is needed, geared towards finding*

sustainable systems" (Bracken; Kvarnström; Ysunza et al, 2005, p.1). Regarding sustainable sanitation criteria, efforts have been made to propose classifications imperative to be concerned about when assessing sanitation systems sustainability (Lennartsson; Kvarnström; Lundberg et al, 2009, p.3). Bracken; Kvarnström; Ysunza et al, (2005, p.2) and SuSanA, (2007, p.2) both propose health, environment, technical, financial and economic, and socio-cultural, as criteria for sustainability assessment. These criteria, with each of them containing some variables are very useful to consider when assessing improvements of sanitation system of Kumasi Metropolis (see table 1).

Table 1. Selected Sustainable Sanitation Criteria, Indicators and Variables

Sustainability Criteria	Indicators	Variables
Health	Risk of Disease	Number of diseases and deaths related to sanitation
Environment	Water Pollution	Milligram of biological oxygen demand per liter in Subin River
Technical	Provision of Sanitation Facility	Robustness of sanitation technology
Financial and economic	Investment and Capital Cost	Amount of money earmarked to sanitation management, Cost of construction of household toilets

Source: Author's Construct, 2016

In a nutshell, this study intends to assess the improvements of sanitation system in Kumasi Metropolitan Area in the Ashanti Region of Ghana within which people face inadequate sanitation using some selected sustainable sanitation criteria.

Purpose and Importance of the Research

The purpose of this study is to answer the question how much improvements have been achieved in the sanitation systems of the Kumasi Metropolis (2008-2015) in terms of sustainable sanitation criteria. Answering this question is very important because lack of adequate sanitation is a major problem across the globe particularly developing countries including Ghana, because exposure to human excreta increases the tendency of getting infected with some sanitation related diseases, notably, diarrhea, dysentery as well as cholera (UNU-INWEH, 2010, p.10) and subsequently leads to death. According to the World Health Organization (WHO), 80 percent of all childhood diseases and illness in the developing country are specifically connected to water, sanitation and hygiene (Annan, 2003). UN Water (2008, p.1) argues that, five thousand children die each day due to infectious diarrhea, a leading cause of poor sanitation. Worldwide, 2.2 million people die annually from diarrhea disease directly associated with inadequate water supply and sanitation, mostly children under the age of five. At the same time, 200 million people are infected with schistosomiasis globally, of which 20 million suffer severely (WHO, 2000, p.2).

Without sanitation systems, human waste deposited during open defecation enters ground water and surface waters, hence contaminate the environment (UN Water, 2008). Like many cities in developing countries and indeed Ghana's capital, Accra, around 80 percent of fecal sludge is released into water bodies causing water pollution and around 20 percent is dumbed at defunct treatment plants (Keraita and Amoah, 2011, p.4). Open defecation preponderates in the developing nations. In Ghana, 19 percent of its total population engages in open defecation making the country ranked second after Sudan in the continent of Africa (Ghana Web, 2015). This is not surprising as recent statistics suggests out of every five Ghanaians three drink water contaminated with human waste (Ghana Web, 2017).

It is on record that lack of adequate sanitation cost Ghana government a whopping amount of 420 million Cedis annually, being equivalent to 290 million United State Dollar (USD). This amount is the equivalent of 12 USD for each person per year or 1.6 percent of Ghana's national gross domestic product (WSP, 2012, p.1). This means the practice of defecating openly has deleterious consequences on environment and water

bodies. It is also a drain on the public purse as colossal amount of money are expended owing to poor sanitation. For example, Van Minh and Viet Hung (2011, p.68) claim that lack of adequate sanitation causes a broad range of harmful impacts on public health and national economies. The enormity of economic losses accompanying inadequate sanitation in developing nations is substantial.

In the year 2014, the government of Ghana through the Ministry of Local Government and Rural Development (MLGRD) introduced National Sanitation Day (NSD), which requires active engagements of citizens to undertake national clean up exercise on first Saturday of every month to conquer poor sanitation conditions in Ghana. The NSD has attracted high profile personalities in the country such as the president of Ghana, Ministers of States, Members of Parliaments, Police Service, Military and Immigration services. Similarly, recognizing the protracted lack of adequate sanitation in Ghana and its associated overwhelming consequences, the newly elected president after the country's December 2016 general elections, created Sanitation and Water Resources Ministry. Arguably this never happens, particularly since transition to multiparty democracy in 1992. It is believed that enough resources will be devoted to this ministry to surmount poor sanitation coverage in the country.

It is estimated that 2.5 billion people in the world have no access to basic sanitation (UNICEF and WHO, 2013, p.5). Because clean sanitation is an essential element of human rights, it is expressed in the Millennium Development Goals (MDGs) rolled out by the United Nations, specifically in the MDG-7 target 10. This is to bring down by one half the percentages of people lacking access to basic sustainable sanitation as measured by the access to sanitation improvement (UN-Habitat 2015, 11). Moreover, the United Nations recognizes the right to water and sanitation in 2010 (Resolution 64/292). According to the United Nations, water and sanitation is prerequisite for actualization of entire human rights. Therefore, it is calling on states to commit enough financial resources, technology for sustainable provision of water and sanitation (United Nations, 2010).

Many studies have been done concerning sanitation in the Kumasi Metropolitan Area. Amoah (2010) for example focuses at the problem of indiscriminate disposal of solid waste and institutions in the Kumasi Metropolis. Ayee and Crook (2003, p.iii) examine

the impact of politics of public private-partnership on urban environmental sanitation in Accra and Kumasi, the two largest cities in Ghana. Nonetheless, as far as we know, not much academic research has been conducted on the assessment of sanitation system improvements in the Metropolis from the perspective of sustainable sanitation criteria. This is a gap this study intends to fill. Additionally, it is expected to develop some recommendations in order to improve sanitation systems within the metropolis towards more sustainability.

Data Collection and Analysis Method

The aim of the study is to find answer to the research question of how much improvements have been achieved of sanitation systems of the Kumasi Metropolitan Area between 2008 and 2015 in terms of sustainability. Sustainability assessment of a sanitation system is a daunting task because provision of sanitation services is a complex issue and there are many criteria that can be used. The data require under each of the selected sustainability criteria, are presented above (see table 1). The sources of these data are public and private institutions, namely, Waste Management Department of Kumasi Metropolitan Assembly, South Suntreso Government Hospital-Bantama, Tafo Government Hospital, Environmental Protection Agency (EPA) and Private Waste Management Companies such as Clean Team Ghana and WasteCare Associates. The researcher visited these institutions during summer holiday to ask questions, documentary reviews, to conduct interviews with key informants to get primary sources of information applicable to this research. Also, secondary sources of data such as reports, books, dissertations, internet, articles were also supplemented to the primary data.

The researcher was born and bred in Kumasi, Ghana. The researcher understands the widely-spoken language, Asante Twi, in the city. So, the researcher has a very good knowledge of the study area, hence this directly informs the decision to choose Kumasi Metropolis as case study to assess its sanitation systems improvement.

Data gathered for this study such as number of diseases and death related to inadequate sanitation, amount of money earmarked for sanitation management, cost of construction of household toilet, were processed and organized for analysis using descriptive statistics. Milligram of biological oxygen demand per liter in water resources (Subin

River), robustness of sanitation technology, were also analyzed relying primarily on secondary data.

Structure of the thesis

The study consists of two main chapters following the **introduction. Chapter one** deals with the review of relevant literature on sanitation, sustainable sanitation and sustainable sanitation criteria to develop an analytical framework for sustainability assessment of sanitation system in Kumasi Metropolis. **Chapter two** presents the case study (Kumasi Metropolitan Area, Ghana), which is concerned with the improvements of sanitation system from the perspective of sustainability. Last chapter contains conclusion and recommendations.

CHAPTER ONE

LITERATURE REVIEW

SUSTAINABILITY ASSESSMENT OF SANITATION SYSTEMS

The major aim of this chapter is to review the literature to find out concepts, methods and criteria that are necessary for sustainability assessment of sanitation systems. Although the terms sanitation, sanitation system, sanitation system managements, sustainable sanitation and sustainable sanitation criteria are popularly used, it is not clear what are meant by them because different authors and organizations have different interpretations. Therefore, this chapter is devoted to clarification of the terms. To achieve this stated aim, relevant literatures have been reviewed. These are journal articles, reports from international organizations (World Health Organization, United Nations Children's Fund etc.), among others. This chapter is divided into three sections. These are sanitation, sanitation system managements, and sustainable sanitation criteria.

1.1. SANITATION

Sanitation like every concept would have varied definitions. McConville (2008, p.2), for example, defines sanitation as the process of getting rid of human fecal waste in way that safeguards public and environmental health. Similarly, Flores; Buckley; Fenner (2008, p.1) also define sanitation as provision of facilities that isolate human excreta from human settlements to prevent disease.

On the other hand, the term sanitation is defined as interventions to minimize public exposure to contracting diseases by keeping a clean environment and proper ways to break the cycle of disease (Schertenleib et al, 2002, p.223). The interventions usually consist of solid and liquid waste management, control of disease vectors, and provision of washing facilities for hygiene. It also includes change in people's behavior and facilities to ensure germ-free environment (Schertenleib; Forster; Belevi, 2002, p.223). According to Avvannavar and Mani (2007, p.2), the term sanitation is the provision of a

clean environment over safe management and environmentally sound disposal of human urine and feces, disposal of solid and liquid waste, and vector-control. Likewise, Jha (2003, p.134) holds the view that sanitation is a term including disposal of human excreta, solid wastes, waste water, personal and domestic hygiene.

Snel and Smet (2006, p.7) contend that sanitation encompasses both the 'hardware' and 'software' needed to reduce fecal-oral disease transmission. Whereas the 'hardware' is latrines and sewers, 'software' consists of education, regulation and hygiene promotion. This definition however implies nutrients recovery and final disposal of human excreta.

Essentially, a sanitation concept is the application of organic fertilizers obtained from waste management and sanitation to improve soil fertility for agriculture purposes (Otterpohl, 2000, p.3). In the European cities, from the middle ages towards the latter part of the 19th century, sanitation was synonymous to reuse of the nutrients in human excreta until the introduction of waterborne systems came to replace dry sanitation (Bodik and Ridderstolpe, 2008, p.23-24).

Analyzing the above definitions, sanitation can be seen to mean, solid waste disposal, change of behavior, hygiene, resource recovery etc. For the sake of this study, the definition propounds by McConville (2008, p.2) and Flores et al, (2008) is offered as the working definition. Preventing exposure to human fecal waste to protect public health includes expanding access to basic sanitary facilities in households and institutions as well as appropriate management of networks of system of sanitation from collection, transport, treatment, reuse and/or disposal of sanitation waste (WHO, no date). The United Nations General Assembly in 2010 through a resolution with states and international organizations articulates access to drinking water and clean sanitation as an essential element of human rights (United Nations, 2010).

1.2. SANITATION SYSTEM MANAGEMENTS

Having defined what is meant by the term "sanitation", the primary goal of this section is to understand sanitation systems and to examine ways by which sanitation systems can be managed. Under "sanitation system", scholarly definitions are provided to appreciate sanitation system components. In the case of "sanitation system managements", a brief introduction is highlighted and subsequently it discusses the

methods of sanitation system managements, namely, decentralized (on-site) system and centralized (off-site) systems. Technology options for decentralized management are also presented.

1.2.1. Sanitation Systems

In the previous decades, many African governments have transformed their water supply and sanitation systems to provide better services to their people, because they need privacy, cleanliness and water to wash themselves quickly and conveniently. This is difficult if water piped is not available on the premises (Banerjee and Morella, 2011, p.83; Satterthwaite; Mitlin; Bartlett, 2015, p.3). They also need quick, simple access to safe and clean latrines without panic whether at day or night. People require sanitation facilities near them to shun lengthy walk, waiting in a long queue, and to avoid spending more than they can easily pay for (Satterthwaite; Mitlin; Bartlett, 2015, p.3).

Toilets facility need to function well to prevent toilet wastes from contaminating people's food and water. Almost all urban people in high-income countries can access toilet when they are in need without considering whether they have time or they can afford. There are regular supplies of piped water at all residential homes, effective storm drains and consistent households waste collection (Satterthwaite; Mitlin; Bartlett, 2015, p.3-4).

"*A sanitation system comprises the facilities and services used by households and communities for the safe management of their excreta. A sanitation system collects excreta and creates an effective barrier to human contact; transports it to a suitable location; stores and/or treats it; and reuses it or returns it to the environment. In addition to excreta, sanitation systems may also carry household waste water and storm water. Transport, storage, and disposal facilities may also manage wastes from sources like industries, commercial establishments, and institutions*" (IFC and WBG, 2007, p.5). According to Hawkins; Blackett; Heymans (2013a, p.12), sanitation system is a sustainable processes and services that ensure safe storage, transport, and treatment of excreta in a managed and coordinated way. Impliedly, for effective and safe management of excreta, sanitation systems should be a chain rather than only provision of toilets. Implementation of toilet facility alone without appropriate arrangements to other parts of the sanitation system components will merely move the problems from

one point to the other. This kind of system layouts can result to problem accumulations in a manner that the result is considerably more negative to the intention of sanitation systems (Pour, 2012, p.17).

The price paid in the absence of sanitation systems is monumental in respect of disease and death, environmental effects and in wasted resources (Drangert; Brew; Winblad, 1997, p.11). Therefore, the effectiveness of any system of sanitation is essential for health and development of child, sustainability of the environment, economic development and personal safety (USAID, 2014). Overall, "*the basic purpose of any sanitation system is to contain human excreta and prevent the spread of infectious diseases, while avoiding damage to the environment. If an alternative sanitation technology can perform these functions with fewer operational and maintenance problems than those associated with conventional VIP toilets, and produce a free, easily accessible and valuable agricultural resource, then the implementation of such a technology should be actively encouraged*" (Austin and Van Vuuren, 2001, p.5). The components of sanitation system are diagrammatically shown below.

Figure 1. Components of Sanitation System

Source: (Singh; Rathi; Patro et al., 2016; De Bruijne; Geurts; Appleton, 2007; UMC, no date)

User interface describes the type of latrine construction with which a user comes in contact. It refers to the way in which the user accesses the system of sanitation. User interface technologies that may be considered, depending on local factors (water, land, customs etc.) are flush toilet, urinal, urine-diversion toilets, etc.

Collection systems explain the ways of collecting, storing, and to some extent treating the sanitation products such as feces, black water, that are generated from the user interface. Typical examples of collection system that may be suitable in different environment involve single pit, twin pit, septic tanks, dehydration vaults, twin and pour flush.

Transport systems explain the technologies used to convey the sanitation products from the user interface or collection system to a (Semi-) centralized treatment facility. Thus, from septic tank to treatment facility center. This takes the form of human emptying, motorized emptying, transfer station and simplified sewers.

(Semi-) Centralized Treatment refers to treatment technologies appropriate for large user groups. Waste stabilization ponds, Co-composting, constructed wet lands and drying beds need to be considered.

Reuse and/or Disposal refers to the processes by which products of sanitation are eventually returned to the environment either as valuable resources or reduced risk materials.

This section has analyzed sanitation systems together with its components, the next part of this study will focus on sanitation system managements.

1.2.2. Sanitation System Managements

Rapid urbanization in low-income urban and peri-urban settlement highlights the need for sanitation technologies and management systems that are technically resilient, financially feasible and contribute no negative impacts to environment (Hawkins; Blackett; Heymans, 2013b, p.3). Sanitation system management basically refers to coordination of activities of the main components of sanitation system that protect public health and minimize environmental pollution. Effective management of excreta remains a continual challenge in low-income cities in developing countries, Ghana is not an exception (Russel; Tilmans; Kramer et al, 2015, p.525). Some experts have argued that management of excreta should be the first problem that needs to be given closed and relevant attention in every locality since the success of advancing public health depends on the efficiency of sanitation management (Faris; Alemayehu; Wubshet et al, 2002). Many methods involve in the management of excreta, ranging between low-cost options and expensive methods encompassing stages of collection and treatment. Generally, sanitation management system falls into two categories: these are decentralized (on-site) system and centralized (off-site) systems (WHO, 2006).

1.2.2.1. Decentralized Sanitation System

In both the developed and developing world, decentralized on-site sanitation is an alternative to the conventional sewerage system for rural and thinly populated settlements. The disparities between them, however depend primarily on the affordability criteria and cultural practices (Viraraghavan; Sundaravadivel; Vigneswaran, 2000, p.4). Decentralized waste water management has come to be used to refer to processes which entail collection, treatment and disposal/reused at or close to the generation point. Thus, it is also called on-site management (Hophmayer-Tokich, 2006, p.14). To ARGOSS (2001, p.17), this system may either demands regular emptying or building new facilities once it is full.

To ensure that management of decentralized sanitation systems do not impact negatively on health and environment, some degree of treatment is needed before discharge or reuse of effluents. The degree of treatment is determined by the option of disposal or reuse. For instance, when waste water is reused pathogen reduction is essential, however less essential when discharged into a watercourse (Parkinson and Tayler, 2003, p.82).

On-site systems may be wet or dry. Wet systems are pour flush latrine, aqua privy, and the septic tank, that make use of water to treat waste. These systems are recommended for areas that have an abundant water supply. It is usually expensive than the VIP latrine, even though some oppose that the cost of the pour flush latrine is similar (Herron, 2011, p.63). Unlike a wet sanitation, dry sanitation methods are made up of pit latrines as well as VIP latrine. Dry sanitation requires no water to dispose of excreta. As an alternative, excreta are broken down by decomposition or dehydration. In decomposition, organisms like worms break down urine and feces. Conversely, dehydration systems separate feces and urine, afterward scatter feces with sawdust, ash to take in the excess moisture and deodorize. The material added too improves the nitrogen content if the feces are considered as fertilizer (Herron, 2011, p.61).

Even though decentralized systems not widely recognized, they appear to proffer some avalanche of potential benefits (Parkinson and Tayler, 2003, p.80).

To begin with, the investment cost related to the construction and operation of decentralized sanitation systems, usually less than and most probably also cheaper than in the case of centralized systems (Parkinson and Tayler, 2003, p.81). Secondly, decentralized approaches for the collection and disposal of fecal sludge are particularly apt; as they allow reducing the distances of transport and along these lines reduce the expense of transportation. Thirdly, decentralized management increases opportunities for effluents reuse. Utilization of recycled water would turn out to be more economical in as much as waste matter would be available near the potential points of generation, consequently cutting down the expenditures of recycled water distribution systems (Hophmayer-Tokich, 2006, p.18). Moreover, decentralized on-site strategy, could reduce water pollution, better than sewer systems devoid of treatment plant if done well (Satterthwaite; Mitlin; Bartlett, 2015). Coupled with this, United States Environmental Protection Agency (1997, p.i) stresses the point that this approach, besides being cost effective in general, offers the option of a long term in the field of health and quality of water in the least populated communities if well managed.

On-site technologies such as pit latrines or toilets with septic tank often used by those poor families in urban areas with access to sanitary facilities. These technologies isolate excreta from human contact while it provides a place to defecate, albeit they too have shortcomings (Russel; Tilmans; Kramer et al, 2015, p.525). In many slums, dislodging takes place by hand due to narrow, poor nature of road designs prevent dislodging of septic tanks and latrine pits with suction trucks, so often the workers involved and members of the community stand the danger of becoming infected with fecal pathogens (Russel; Tilmans; Kramer et al, 2015, p.525-523). Furthermore, on-site methods often represent a great threat to ground water in that feces pile up in a place and leaching of contaminants in the environment can arise (ARGOSS, 2001, p.19). Finally, to Wilderer and Schreff, (2000) and Bakir (2001), the establishment and operation of many small on-site systems is believed to be more costly than establishing a central system. In addition, the operation and maintenance of a vast number of on-site systems will be higher than in the central system. Wilderer and Schreff observe that decentralized system may be considered as a feasible alternative, if very effective in the treatment and the ease of operation and low cost.

Technology Options of the Decentralized Management

The choice of technology hinges on economic issue, technical as well as social issues and each sanitation technology has its merits and demerits (ARGOSS, 2001, p.19). The following explains some of the on-site sanitation technologies for excreta disposal.

1.2.2.1.2. Pit Latrines

A pit latrine encompasses a hole in the ground with a floor/squatting slab enclosed by a latrine house. It is one of the simplest and inexpensive ways of disposing of human wastes. The simple pit latrine requires a stable soil, as there is a possibility for the pit to collapse. Finally, and very importantly, the pit is constructed well above the ground water table, as supply of drinking water can be contaminated (Uusitalo, 2002, p.13).

1.2.2.1.3. Ventilated Improved Pit (VIP) Latrines

Ventilated Improved Pit (VIP) latrine is an improvement compared to the traditional latrines in two respects: they alleviate the harmful smell and reduce number of flies and other insects that trouble users of traditional latrines. In a VIP latrine, there is a vent pipe that allows fresh air to flow through the latrine, thus reducing smell. The vent also permits light in to the latrine, attracting flies into the pipeline, where they are trapped by the fly screen at the top of the pipeline. The screen also denies flies entering the pipeline from the outside (Herron, 2011, p.61).

1.2.2.1.4. Pour-Flush Latrines

A pour flush latrine is applicable in areas where water is available on a broader scale. This latrine can provide several additional benefits over and above simple or VIP latrines. It has water seal created by a U-bend plastic which avoids awful smell and flies that affect users. Pour flush latrine requires only small amount of water so as not to constitute burden on resources that can be obtained by grey water from the kitchen. This latrine type reduces flies and other unpleasant smell. Again, building pour flush latrine is easy as a VIP latrine. On the other hand, making Plastic U-bend to prevent flies, odor requires skillfulness (Boot, 2008, p.5).

1.2.2.1.5. Septic Tank

A septic tank is an on-site sanitation connected to flush-toilets to be able to collect household waste water or what is called sullage. Households with acute water shortages or erratic flow of water could face difficulties operating septic tanks given that flush toilets generally tend to work with substantial amounts of water. Consequently, septic tank is commonly used only by communities having access to water in their buildings, homes, space, and have the wherewithal to pay for the tanks emptying cost. This makes it an expensive means of addressing sanitation challenges. The tank is offset from and connected to household latrine and waste water by a short of drainage. It was the intention to hold solid materials and is connected to soak away to dispose of liquid waste. Compare with sewage system, septic tanks give similar comfort to its users (WHO, no date, p.43-44). Septic tank reduces unpleasant odor and flies. In contrast, it requires emptying at regular intervals. Septic tank comes at a huge cost including land acquisition cost (Boot 2008, p.7).

1.2.2.1.6. Aqua Privy

An aqua privy is akin to septic tank as it can be connected to flush latrines for collection of waste water from households. Aqua privy is composed of a huge tank with a water seal formed by a pipe into the tank to control odor and flies. Its disadvantage is that, it is necessary to add water every day to preserve the water seal but it is sometimes difficult to do so unless piped water is connected into the home (WHO, no date, p.44). Boot (2008, p.6) opines that the system may be unsuccessful to control odor if the water seal is not preserved. To get rid of effluent the tank is connected to a soak away. unlike a septic tank, aqua privy is situated immediately below the house. It must have access to a vacuum tanker to engage emptying of tank on a regular basis. It provides no real benefits and it is costly to operate (WHO, no date, p.44).

1.2.2.2. Centralized Sanitation System

Centralized sanitation system comprises central collection system (sewers) for the collection of waste water from households and commercial areas, industries, institutions and transport it to central station for treatment in an offsite location outside the settlement. The disposal/reuse of the treated waste water normally away from the point

of generation. Thus, it is also called off-site management (Hophmayer-Tokich, 2006, p.8). Prior to the centralized sanitation system, households were depositing their waste in the streets leading to the outbreak of diseases such as cholera, typhoid, among others in the major cities of both the central Europe and United States of America (Hophmayer-Tokich, 2006, p.8). Centralized sanitation approach has been developed in the mid-19th century because of continued upsurge of urbanization and urban life, for large concentration of people lead in locally generation of more waste water (Hophmayer-Tokich, 2006, p.8). Studies were done to ascertain the causes of disease outbreaks, and it was discovered that the diseases are triggered by the direct contact of human excreta through the spread of micro-organisms in the excreta. As a result, public sewer systems were constructed for waste water collection and transportation as a panacea to the problem (Hophmayer-Tokich, 2006, p.8).

Centralized sanitation system is pervasive in urban areas in the industrialized countries like Germany, Israel etc. with developments in technology for treating effluents only, to match the needs of the people served and adaptation to changing requirements regarding public health and the environment (Hophmayer-Tokich, 2006, p.10). In Germany and Israel, for example, more than 95 and 96 percent of the population, respectively are networked with sewer system.

The advocates of centralized sanitation posit that introduction of centralized sanitation infrastructure on a large scale in Germany and other major cities in industrialized countries and elsewhere have eradicated all kinds of waterborne and sanitation related diseases (Hophmayer-Tokich, 2006). Kumar (2013, p.64) claims that centralized systems are more hygienic than traditional decentralized systems. Another argument is that centralized-off-site sanitation facility offers more convenience than decentralized methods and responsibility concerning the treatment and waste disposal often remains with the local authority (ARGOSS, 2001). There are lots of cities whose local authorities have no financial or institutional capability to extend sewerage system to informal settlements (Satterthwaite; Mitlin; Bartlett, 2015, p.9). Centralized sanitation system strategy has become the standard tool of control and protection of the environment. Since the late 19th century until today it is still the preferred method in the management of urban sanitation in Germany, Israel, and serving in the largest cities as

well as towns in many countries of Europe and other developed countries (Hophmayer-Tokich, 2006, p.10).

In opposition, this system seems unfeasible in low-income or developing countries including Ghana, because of the huge investment costs required in areas such as laying a network of underground pipes, operation and maintenance, skilled manpower and waste water treatment plants (Montalbo; Samarakoon; Visvanathan et al, 2007). In Kampala, Uganda, sewerage network system serves only around 7 percent of the population in the Central Business District and the well-off areas. Almost 93 percent of the poor population in urban areas primarily are dependent on different forms of on-site sanitation such as pit latrines and septic tanks (NIUA, 2015, p.43). Further, In Abidjan (Ivory Coast) and Durban (South Africa), 40 percent of the urban occupants benefit from sewer system. Subsidizing sanitation is an important part of a policy to improved sanitation (Kariuki; Collignon; Taisne et al., 2003, p.69). Besides, conventional sewerage is expensive to operate and requires consistent in-house flow of piped water and energy supplies for transporting excreta through the sewerage network (ARGOSS, 2001; Tilmans; Russel; Sklar et al, 2015, p.89). Sewerage is regarded as appropriate form of sanitation, but evidence from Europe indicates that it may cause contamination of ground water with microbiological and nitrate through leaking sewers (ARGOSS, 2001, p.17). By way of illustration, in Germany, ground water pollution and contamination from leaking sewers is roughly 15 percent in view of a survey which registered 17 percent of the public sewerage system (Dyk and Lohaus, 1998). Again, in the same country, several 100 million cubic meters' waste water leaks annually from damaged sewer pipes (Eiswirth and Hötzl, 1997, p.399).

Like developing world and in Ghana, vast number of people are served on-site than sewerage systems. For example, in Africa, waterborne sewerage is rare. Pit latrines are the most used sanitation as well as the fastest growing (Kjellén; Pensulo; Nordqvist et al, 2011, p.19). In urban and rural areas in Sub-Sahara Africa, pit latrines are the most widely sanitation operated. In South-east Asia, the dominant form of sanitary facilities is the septic tank (Kjellén; Pensulo; Nordqvist et al, 2011, p.19). India including other Asia countries, have no clearly dominant sanitation systems. They have mixed systems of sanitation. China and Latin America have dominant sewerage systems, particularly in urban areas.

In brief, sanitation systems in the developed world tend to use a water-based flush toilet that requires significant investment in waste water treatment plants, pipes and sewers. Contrary to least developed countries including Ghana, decentralized systems of sanitation deliver a cost-effective including viable alternative and above all may increase sustainability by reducing environmental impact. Certain types of technologies for decentralized sanitation like ecological sanitation system are aimed at recycling of waste (Berendes; Levy; Knee et al., 2015, p.1-2).

Hawkins; Blackett; Heymans, (2013a, p.3) hold the view that sewerage washes away fecal matter by a system of pipes with water to pumping stations. Fecal sludges on the other hand are accumulated on-site either in a pit latrines or septic tanks, regularly emptied, then transferred by road to treatment. Both ways will cause pollution with fecal matter and adversely threaten public health in case there is any deficiency in the sanitation system components.

As pointed out in the introduction to this research study, the aim of the present study is an assessment of sanitation system improvements in Kumasi Metropolis from the point view of sustainability. Having looked at sanitation system managements, it is also important to understand the context of improved sanitation. This is explained below.

1.3. IMPROVED SANITATION

Improved sanitation as defined by UNICEF/WHO are those most likely to ensure that human excreta are hygienically separated from human contact. A well-known example of improved sanitation is classified as a piped sewer system, septic tank, pit latrine, Ventilated improved pit (VIP) latrine, Pit latrine with slab and Composting toilet. Unimproved sanitation on the other hand, does not ensure human excreta are hygienically separated from human contact, and classic examples include pit latrines without a slab or platform, hanging latrines, and bucket latrines (UNICEF and WHO, 2013, p.12).

In 2011, it is estimated that 2.5 billion people in the world lack access to sanitation facility considered to be improved. 761 million out of this 2.5 billion people uses shared sanitation facilities and 693 million use facilities that fall short of minimum requirements of hygiene. The remaining 1 billion constituting 15 percent of the global

population still resort to open defecation (UNICEF and WHO, 2013, p.5). Ghana is part of this statistics. UNICEF and WHO (2012, p.21) report that apart from the Eastern Asia, the evidence of shared sanitation is also seen in Sub-Saharan Africa countries, Ghana, Congo, and Gabon.

Shared and public sanitation is not regarded as improved under the UNICEF/WHO definitions of improved sanitation since they are not hygienic and even more, may not be accessible during the night (UNICEF and WHO, 2013, p.12; UNICEF and WHO, 2012, p.21). A study by O'Keefe; Christoph; Kamara et al (2015) in Nairobi and Kampala, and Peprah; Baker; Moe et al (2015) in Accra, Ghana, corroborate this assertion. But O'Keefe; Christoph; Kamara et al, note that inability for the people to access public toilets around the night compel them to engage in open defecation or disposal of solid waste with human excreta. This practice may have serious implications on community health in developing countries, especially if comprehensive policies are not put in place to deal with the difficulties. A preponderance of studies claims that accessibility of sanitation service improvement averts the escalation of diseases associated with human fecal waste. Mara; Lane; Scott et al, (2010) assert water and sanitation improvement can abate the prevalence rate of diarrhea illnesses by 32 to 37 percent. Likewise, in Rio Grande do Norte in Brazil, diarrhea, the cause of child mortality has been decreasing substantially between 70 and 40 deaths per 1000 cases (Andrade; Queiroz; Cabral et al., 2009). This suggests that sanitation improvement is pivotal in the development of a country and Ghana is not an exception.

1.4. SUSTAINABLE SANITATION CRITERIA

So far, the above section has focused on "sanitation", "sanitation system" and "sanitation systems management", the following section will discuss "sustainable sanitation"; "sustainable sanitation criteria", and finally present "measurements of sustainable sanitation".

1.4.1. Sustainable Sanitation

The concept of sustainability emerged when the deliberation on sustainable development began in the early seventies. Since then, it has somewhat become a complex and disputed concept (Pretty, 2013, p.209). Abrams (1998) defines

sustainability as whether something remains to work in the course of time or not. Abrams argues that for flow of water to continue, all the many elements necessary for sustainability need to be present. He identifies five of these elements, namely, environment, technical, financial, social and institution. Abrams clarifies that, for recurrent expenditure and occasional maintenance money need to be in place. There must be also acceptance from the clients of the service. Furthermore, the source that supply the service must be adequate, design must be done properly couple with sound construction. Fiksel (2006, p.16) posits, the efforts following realization of sustainability are concentrated at decreasing environmental burdens measured in terms of resource consumption and emissions of waste.

A published report in 1987 by the World Commission on Environment and Development (WCED) otherwise known as the Brundtland Report, defines "*sustainable development as development that meets the needs of the present without compromising the ability of future generations to meet their own needs*" (WCED, 1987, p.43). Sustainable development is the issue of tackling the growing trepidation on the rapid deterioration of the environment and natural resources and the impacts of the deterioration for socio-economic development.

In recent times, sanitation sector has become one of the most important sectors that have been given considerable attention due to the potential to contribute towards a more sustainable society (Schwidder; Strauch; Stockel, no date). Sustainable development and sustainable sanitation are coterminous. Accordingly, "*sustainable sanitation was defined to mean, meeting the basic sanitation needs of all population segments of the present generation within a city (principle of equity) without compromising the needs of the present and future generations living inside and outside of the city*" (SuSanA, 2008, p.5). Sustainable sanitation is the decision-making process for health and the environment, technology and finance as well as social-cultural (WSSCC, no date). Sustainable approach to sanitation is considered holistically. The reason stems from the fact that sustainable sanitation recognizes that human excreta and waste water are resources, following an observation established on the basis that waste water and excreta contain considerable amount of energy, water along with plant nutrients that can be recycled and reused to save natural resources from harm (Conradin, no date).

Worldwide, waste water is known as the primary pathway for spreading diseases, sustainable sanitation systems have such solutions that can be applied to check fecal exposure (Bodík and Ridderstolpe, 2007). "*The main objective of a sustainable sanitation system is to protect and promote human health. This is done by providing and maintaining a clean environment without fecal contamination and by adopting measures that break the cycle of disease transmission. To achieve the direct effects of containment and reduction of pathogenic organism the system should be technically appropriate, economically viable, socially acceptable, and institutionally manageable which are factors that all affect the health outcomes*" (Stenström; Seidu; Ekane et al, 2011, p.1).

An approach to sustainable sanitation is ecological sanitation (EcoSan). Sustainable sanitation is an evolving concept. In other words, sustainable sanitation is not a fixed or constant idea. Ecosan system is basically an approach that considers nutrients and organic matter in human feces and urine as a resource, not as a waste. As a resource, it produces food or other gains for people. It contributes to environmental and human health by way of minimizing disease transmission and wastes disposal, and achieving food security by recovering water and nutrients (Esrey, 2000, p.179). Ecosan has been embraced in many countries around the globe. In Guangxi, China, urine and feces are used on farmlands to grow rice and corn. In Mexico and India, excreta are considered valuable nutrients. In urban and rural areas of Ethiopia, EcoSan is also being experimented (Esrey, 2000, p.186-187). This approach is a paradigm shift from other approaches to sanitation (on-site and off-site). Ecologically, EcoSan system protects environment from contamination while in conventional sanitation, there is pollution of ground and surface water. Financially, EcoSan is tailored to community budgets while conventional sanitation requires huge infrastructure investments. In terms of health, less disease is transmitted in the case of EcoSan system. On the other hand, conventional sanitation potentially transmit disease. Lastly, in EcoSan, it is easier to access nutrients whereas conventional sanitation is dependence on expensive fertilizers (Esrey, 2000, p.185-186).

This section has reviewed sustainable sanitation, the section that follows will explain sustainable sanitation criteria.

1.4.2. Sustainable Sanitation Criteria

Urban communities these days encounter problems of an adequate (improved) system of sanitation implementation in a sustainable development channel (Vera, 2007, p.3). When designing a new system of sanitation, the following criteria in relation to the aspects below should be considered (SuSanA, 2007, p.2).

1.4.2.1. Health

Sustainable sanitation should safeguard human health and prevent diseases. Diseases connected to inadequate sanitation include diarrhea, cholera, malaria, schistosomiasis and dysentery. Health sustainability indicators according to Bracken; Kvarnström; Ysunza et al, (2005), Lennartsson; Kvarnström; Lundberg et al, (2009, p.6) and SuSanA, (2007, p.2) are risk of infection from pathogens, risk of exposure to hazardous substances and the hygiene. Variables regarding health include number of disease cases and number of deaths reported at medical centers that are related to poor sanitation.

1.4.2.2. Environment

Sustainable sanitation should not contribute to environmental degradation. According to Lennartsson; Kvarnström; Lundberg et al, (2009, p.6), indicators of environment are quality of product recycled, reusing of water and nutrients. To Bracken; Kvarnström; Ysunza et al, (2005) and Balkema; Preisig; Otterpohl et al. (2002), environmental indicators cover consumption of resources (water, energy, land), impact on biodiversity, natural system and land fertility, risk of environmental hazards to air, water, and soil, compliance with environmental standards as well as reuse and recycling of resource conservation. Environmental variables could be amount of Biological/Chemical Oxygen Demand (BOD/COD) per liter in water bodies, percentage of nutrients used from recycled sources and percentage of reclaimed water used in agriculture.

1.4.2.3.Technical

Sustainable sanitation should be technically appropriate for the society. This deals with robustness of system (effect of failure, robustness against severe condition, risk of failure), adaptability and flexibility to user needs and environmental conditions. Technical indicators also cover durability, odor, ease of system monitoring,

compatability with existing system, technical expertise as well as parts accessibility (Lennartsson; Kvarnström; Lundberg et al, 2009, p.6; Bracken; Kvarnström; Ysunza et al, 2005). Technical variables include percentage of households with year-round access to water, robustness of sanitation technology, etc.

1.4.2.4. Financial and Economic

Sustainable sanitation system should be inexpensive for the society. It should also ensure appropriate investment in sanitation management. Financial and economic indicators relate to affordability (capital and annual cost, operation and maintenance), willingness of users to pay, investment cost, (Lennartsson; Kvarnström; Lundberg et al, 2009, p.6; Bracken; Kvarnström; Ysunza et al, 2005). The variables connected to financial and economic may be cost of construction of household toilets, amount of money earmarked to management of sanitation.

1.4.2.5. Socio-cultural

Sustainable sanitation should protect people dignity by ensuring safety and security. The indicators of socio-cultural criteria involve convenience (smell, comfort, privacy, attractiveness, adaptabilty to gender, adaptability to different age, adaptabilty to different income groups), institutional requirements (organizational structure, policy), safety, capacity to address information needs and awareness, legal acceptabilty (Lennartsson; Kvarnström; Lundberg et al, 2009, p.6, Bracken; Kvarnström; Ysunza et al, 2005; SuSanA, 2007, p.2). Socio-cultural variables could be number of households without toilet, percentage of households with toilet and lastly, percentage of population with hygienic and clean toilet.

Sanitation systems are composed with the cognizance of all these criteria. However, sanitation systems are not successful because not many of the criteria have been met. No system is completely sustainable. The sustainability concept is considered as a journey, rather than a stage to reach. The possible explanation could be that there is no solution to sustainability, however, irrespective it is very crucial to evaluate sanitation systems giving to all these dimensions of sustainability.

A principle dubbed "Bellagio principles" were developed years ago by a group of experts and approved by the memberships of Water Supply and Sanitation Collaborative Council. The principles for sustainable sanitation are enumerated below:

(a) "*Human dignity, quality of life and environmental security at household level should be at the center of any sanitation approach*".

(b) "*In line with good governance principles, decision making should involve participation of all stakeholders, especially the consumers and providers of services".*

(c) "Waste should be considered a resource, and its management should be holistic and form a part of integrated water resources, nutrient flow and waste management processes".

(d) "The domain in which environmental sanitation problems are resolved should be kept to the minimum practicable size (household, community, town, district, catchment, and city)".

This part has examined the criteria for sustainable sanitation, the succeeding section will clarify a range of measurements as far as sustainable sanitation is concerned.

1.5. MEASUREMENTS OF SUSTAINABLE SANITATION

Indicators are very useful in measuring progresses and performances of water and sanitation projects. It makes successes or failures noticeable and with an exact influence on the indicators problems can be resolved (SSWM, no date,). Sustainability indicators serve as guide to policy makers at diverse levels so they can contribute to the advancement of society on the way to sustainability (Lundin, 2003, p.1). A litany of dimensions has been provided towards evaluation of water and sanitation sustainability. These are tabulated below.

Table 2. Measurements of Sustainable Sanitation

Criteria	Indicators	Variables	Measurements
Health	Risk of infection, risk of exposure to hazardous substances, hygiene	Diseases and deaths due to poor sanitation	Number of disease cases: dysentery, cholera, typhoid, schistosomiasis etc), and deaths reported to health facility.
Environment	Water quality	Dissolve oxygen concentration, phosphorous concentration, suspended solids, nitrate content in rivers, risk of environmental hazard	Amount of BOD/COD in rivers (milligram of oxygen per liter).
	Risk of environmental hazards to air, water and soil,	Untreated sewage and treatment of waste water	Percentage of untreated or poorly treated sewage dicharged into environment, ratio of industrial waste water treatment before disharge.
	Reusing of water and nutrients	Nutrient reused and emissions of carbon dioxide	Percentage of nutrients used from recycled sources, and percentage of reclaimed water used in agriculture to total agricultural water use.
Technical	Construction, operation and maintenance, robustness, easy of system monitoring, durability, odor	Provision of sanitation facilities, levels of depreciation.	Robustnss of sanitation technology, percentage of households with year-round access to water.
Financial and economic	Affordability, annual cost, investment and capital cost, operation and maintenance	Vacuum tanker acquisition, public expenditure to deal with diseases	Number of vacuum trucks purchased to manage sanitation
Socio-cultural	Convenience (privacy, smell, comfort), safety, institutional requirements(organizational structure, policy), capacity to address information needs and awareness	Provision of sanitation facilities, levels of depreciation.	Number of households without toilet, percentage of population using hygienic sanitation facilities, and percentage of households with access to a sanitation facility.

Source: De Sherbinin and Bitter (2003, p.3), Balkema; Preisig; Otterpohl et al. (2002), SSMW, (no date), Zhang; Uwasu; Hara; et. (2011:1078), Iribarnegaray; D'Andrea; Rogriguez-Alvarez et al (2015), Bracken et al (2005), Bracken; Kvarnström; Ysunza et al, (1999), and Hellstrom; Jeppsson and Karrman (2000).

These are all combination of variables that can be applied in any geographical locations to assess sustainability of sanitation systems, however specific features in a specific context may influence the kinds of variables to use. Within the context of Kumasi Metropolis, the following selected criteria and variables are adopted to assess the improvements of sanitation system. These selected criteria and variables are health (number of diseases and death related to sanitation), environment (milligram of biological oxygen demand per liter in Subin River), technical (robustness of sanitation technology), financial and economic (amount of money earmarked to sanitation management, and cost of building household latrines).

1.6. CONCLUSION

This chapter has clarified the basic terms of the study, namely sanitation, sanitation system managements, and sustainable sanitation criteria in order to construct an analytical framework for the case study. First, the concept of sanitation (that is, working definition) has been clearly spelt out. Second, an introduction of sanitation systems, components of sanitation system, sanitation system managements, which followed by a detail discussion of decentralized and centralized sanitation as the two main methods of excreta managements, and on-site sanitation technologies have been clarified. The concept of sustainable sanitation and sustainable sanitation criteria have also been explained in this chapter. Lastly, measurements of sustainable sanitation have been operationalized.

The next chapter intends to assess sanitation system in Kumasi Metropolis, Ghana, using the framework constructed in this chapter.

CHAPTER TWO: CASE STUDY

ASSESSMENT OF SUSTAINABLE SANITATION IN KUMASI-GHANA (2008-2015)

Overall, the aim of this chapter is to assess the improvements of sanitation systems in Kumasi Metropolis in terms of sustainable sanitation. To achieve this aim, firstly, how needed data were collected and analyzed is explained. Secondly, background information on case study area is provided. Then data collected on sustainable sanitation criteria are presented and analyzed.

2.1. DATA COLLECTION AND ANALYSIS METHODS

The study in respect of some selected sustainable sanitation criteria aims to assess sanitation system improvements in Kumasi Metropolis, Ghana, between 2008 and 2015. As indicated previously, the sustainable sanitation criteria include health, environment, technical, financial and economics, and socio-cultural. To achieve this stated aim, the following have been clearly defined.

2.1.1. Data Requirements

Selection of sustainability criteria depends on context. In the context of the study area (Kumasi) the following selected criteria, indicators and variables have been chosen as basis for the collection and assessment of improvements of sanitation system. (See table 3 below)

Table 3. Selected Sustainable Sanitation Criteria, Indicators and variables

Sustainability Criteria	Indicators	Variables
Health	Risk of Infection	Number of diseases and deaths related to sanitation
Environment	Water Pollution	Milligram of biological oxygen demand per liter in Subin River
Technical	Provision of Sanitation Facility	Robustness of sanitation technology
Financial and economic	Investment and Capital Cost	Amount of money earmarked to sanitation management, Cost of construction of household toilets

Source: author's construction, 2017

There are many indicators for each criterion and many variables for indicator. A litany of reasons may influence different researchers in the selection of variables to investigate in a specific context. In this research study, dearth of financial resources, lack of time and data availability restrained the selection of these variables for assessing sanitation system improvements in Kumasi Metropolis.

2.1.2. Sources of Data

Having made clearly the kinds of data the researcher needs to attain the overall objective of this study, it is essential to state the sources of these data, basically, where these data were obtained. Data for this research were principally obtained from public and private institutions. Public institutions are the Waste Management Department of Kumasi Metropolitan Assembly, South Suntreso Government Hospital-Bantama, Tafo Government Hospital, and Environmental Protection Agency (EPA). Conversely, private institutions are Clean Team Ghana and WasteCare Associates.

Secondary data was also obtained from published articles, reports, books, dissertations, internet and other researches undertaken that relate to the topic under investigation.

The sources of data have been stated in this section; the section below will explain how the data in **table 3** were collected from the institutions.

2.1.3. Data Collection

In research work, how data is collected is very supreme. At the last quarter of 2015, the researcher being a Ghanaian by nationality went to Ghana for various purposes. Chiefly among one of them is data collection for the use of this research work. With a copy of letter from my supervisor (copy attached to the appendices page) to facilitate data collection activities the researcher spent two months (November-December) in Ghana collecting data by visiting institutions.

In this study, both quantitative and qualitative data were used by way of some techniques of data collection such as questionnaires, interviews, telephone calls, mails and reviewed of documents. The researcher sent emails and phoned WaterAid Tamale branch, Ghana, WSUP Ghana, Clean Team Ghana, Coalition of NGOs in Water and Sanitation (CONIWAS), etc. To Yin (2009, p.19) some case studies research goes beyond being a kind of qualitative, by using a combination of quantitative and qualitative data.

Quantitative method of research focuses on data in the form of numbers that can be analyzed using statistical techniques (Walliman, 2011, p.71). Computer software, namely Microsoft Excel and Statistical Package for the Social Sciences (SPSS) are used to do all the calculations and presentations of data (Walliman, 2011, p.114). The greatest advantage of quantitative research method lies in its general acceptance by others as being rational, logical, planned and systematic. Findings of quantitative research are considered as credible. Furthermore, the researcher is unbiased, objective and, therefore, honest (Roger, 2008, p.42). Notwithstanding these strengths, quantitative research strategy consumes a lot of time, as the researcher needs to enter, clean and then analyze the data. Again, it disregards a very important human influence. (Ukaid and USIP, undated, p.5).

Qualitative data in the form of ideas, customs, and beliefs, cannot be accurately measured and counted, because they are expressed in words rather than numbers (Walliman, 2011, p.72). In the same way, qualitative data takes a great deal of time. Besides this, it is not always possible to obtain direct contact to the subject of research (Walliman, 2011, p.70).

Purposive sampling was adopted to select my interviewee otherwise known as respondents as far as this research are concerned. A purposive sampling according to Merriam (1998) is based on the belief that the researcher wants to know, understand and acquire knowledge and must therefore select a sample from which the largest number could learn. Differently worded, it can be defined as a process that involves the deliberate selection of some participants who have the qualities a researcher is attempting to understand for a study (Etikan; Musa; Alkassim, 2016, p.2). The researcher has interviewed five officers to obtain primary data. These officers have the distinctive characteristics in responding to questions the researcher posed to them towards understanding the topic under study. This is called “key informant interview”. The interviewed officers included the Public Health expert of Kumasi Metropolitan Assembly’s Department of Waste Management, Deputy Director of public health of Ghana Health Service (GHS), Ashanti Region, Senior Technical Officers of both South Suntreso and Tafo Government Hospitals Health Information Department, and Head of Research of Clean Team Ghana. Apart from primary sources of data, secondary data was obtained by reviewing journal articles, reports, books, dissertations as well as searches on internet.

2.1.4. Data Analysis Method

The preceding section has explained the methods of data collection. This section explains the techniques of data analysis.

Descriptive statistics was used to analyze the data collected. Health criteria for instance with the indicator (risk of infection) and variable (number of diseases and deaths related to poor sanitation) was analyzed through descriptive statistics. At the same time, descrpitive statistics was employed to analyzed financial and economic criteria, with indicator, investment and capital cost, and variables, amount of money earmarked for sanitation management as well as cost of construction of household toilets. This type of analysis according to Zikmund (2003) involves the transformation of raw data into a

form that will make them easy to understand and interpret; rearranging, ordering, and manipulating data to generate descriptive information. Alternatively, descriptive statistics gives numerical and graphic procedures to summarize a collection of data in a clear and understandable way (Jaggi, 2003). It helps us to simplify copious amounts of data in a reasonable way. All the collected data except environment and technical data were entered into the Microsoft Excel 2016 and line graphs were produced.

The environmental variable (milligram of BOD per liter in the Subin River) and technical variable (robustness of sanitation technology) relied predominantly on secondary data such as journal articles, dissertations, reports, and so on.

2.2. Limitations of the Study

This study is no different than other studies elsewhere in terms of major challenges researchers encounter during data collection. As a matter of fact, some local government staff and experts in the field of sanitation were not available to be interviewed due to their busy schedule. The few the researcher granted interview (both the public and private institutions) could not address the interview questions fully due to their limited time even though interview appointment was arranged and agreed upon.

Another limitation is data accessibility. Certain relevant data required from specific public and private institutions were difficult to obtain because of their confidentiality in nature. For instance, head of researcher of a private waste management company in Kumasi stated, we just finished preparing our annual report and sorry to say that it is not for public consumption. Again, quantitative data especially on the environmental variable was difficult to get from appropriate institutions. For instance, according to the EPA office in Kumasi, their computers had crushed and unable to recover loss data. The officer whom the researcher met at first visit at EPA laughed in an uncontrollable manner when the researcher indicated to him the kind of data looking for, that is BOD. The officer subsequently asked whether the researcher is a science student. The visit to Dompoase landfill site, Kumasi, revealed that the officer in charge of calculating the contamination levels of Oda River, where excreta are discharged after treatment, had stopped coming to work because of issue of delay in salary and other emoluments. Visit to head office of the Ghana Water Company Limited, Kumasi, did not yield any positive results after interacting with the Human Resource for Production. Moreover, the researcher was thrilled when received email from the Water Resources Commission

(WRC) on information requested, unfortunately those data were on pollution of rivers and streams in other regions of Ghana, contrary to what the researcher asked for. Data on number of deaths related to schistosomiasis, intestinal worms and diarrhea also could not be found.

Data that were collected through emails and phone calls from individuals, relevant institutions and departments who can assist in the research came with its own challenges. The reactions towards those emails and phone calls were mixed. Some had responded, some had not. Those who had responded either provided accurate information that the researcher requested or they do not have such specific data. Also, attempt to get those who had not responded after copious reminders proved abortive.

In addition, those data the researcher obtained too did not cover the proposed period (years) of study. For instance, data on the number of deaths, amount of money earmarked for sanitation management and cost of building household latrines. Final limitation has to do with time. The researcher had limited time to collect all the necessary information important to the study.

The study would have been effective if the researcher had found statistical data on milligram of BOD in Subin River, amount of money government spent to control diseases known to be caused by lack of adequate sanitation, and number of households without and with toilet in Kumasi. Despite the limitations that confronted the researcher for the period of data collections, these limitations will not undermine the quality of the results of the research study.

This entire section has so far clarified the methods of data collection, data analysis and study limitations during data collection; the following section in this study will explain the profile of Kumasi Metropolis.

2.3. PROFILE OF THE KUMASI METROPOLITAN AREA

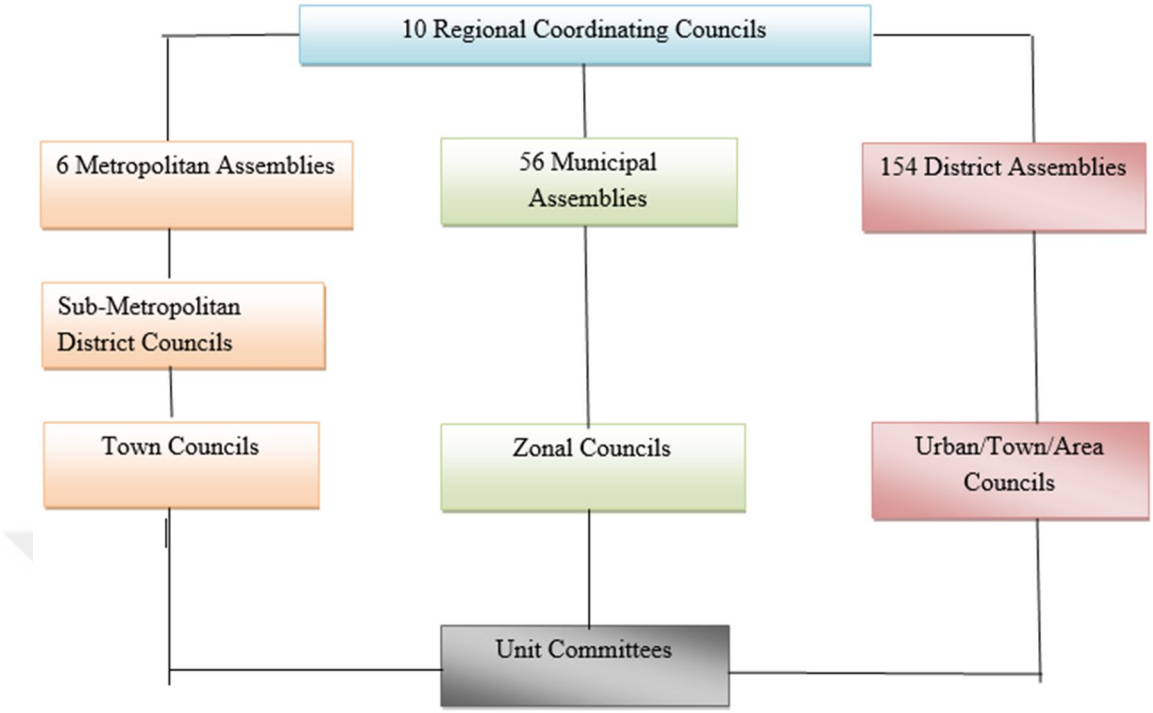
The aim of this section is to describe the Kumasi Metropolitan Area in Ghana in order to provide background information for the case study before assessing sanitation system. This section is explained in terms of political and administrative structures in Ghana, location and demography, social, environmental characteristics and poverty situation.

2.3.1. Political and Administrative Structures in Ghana

Ghana is a country located in the West Africa Sub-region. Besides being a unitary state, it is also a constitutional republic with two levels of government; central and the local government (CLGF, no date, p.61). Administratively, the country is divided into ten regions with 216 districts or local government authorities. Each region is headed by a regional minister appointed by the president, who doubles as the head of state and head of government elected by universal adult suffrage for four years for a maximum of two terms, in a competitive election supervises by electoral commission of Ghana (CLGF, no date, p.61).

At the local level, the highest political, planning and administrative authority is vested to the local government authorities. Local government authorities include Metropolitan, Municipal and District Assemblies (MMDAs). Metropolitan Assembly consists of urban areas with people greater than 250,000. Likewise, Municipal Assembly is a single town assembly with people starting from 95,000 and beyond whereas District Assembly covers rural areas as well as small towns with inhabitants of 75,000 or more (CLGF, no date, p.62).

At the sub-national level, different structures have been designed with the Regional Coordinating Councils (RCCs) acting as coordinating bodies. There is a RCC in each of the ten regions in the country. Below the RCC are the MMDAs and the Sub-district structures (ILGS, 2007, p.9). At the sub-regional level in Ghana, there are 6 Metropolitan, 56 Municipal and 154 District Assemblies. Additionally, there are sub-district structures which include sub-metropolitan district council, urban, town, area, zonal council and unit committee, the lowest in the structure and estimated to be roughly 16,000 (unit committees) nationwide (CLGF, no date, p.62). Ghana's Local governments perform very significant roles in local areas administration and development (ILGS, 2007, p.9). They are responsible for the delivery of sanitation services, public health, basic education, and environmental protection (CLGF, no date, p.61). Figure 5 below shows the local government structure in Ghana.



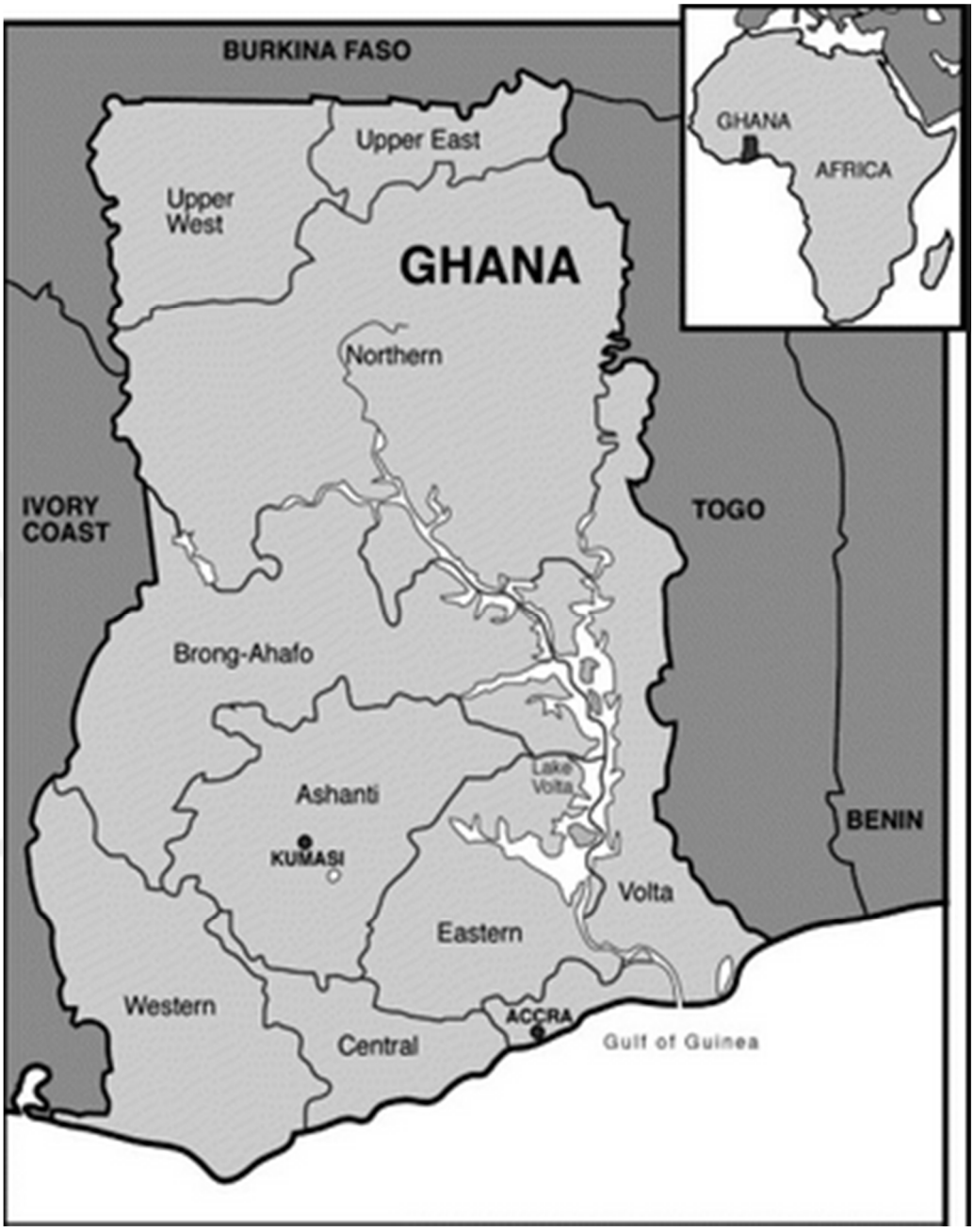
Source: Author's construct, 2017

Figure 2. Structure of Local Government in Ghana

2.3.2. Location and Demography

Ashanti Region has thirty (30) districts and Kumasi Metropolis is one of them. The Kumasi Metropolis is situated in the transitional forest zone and it is around 270km north of Accra, Ghana's regional capital. Kumasi is within latitude 6.35^{o} – 6.40^{o} and longitude 1.30^{o} – 1.35^{o}, ranging from 250 to 300 meters above the sea level. The metropolis land area is approximately 254sq/km and about ten (10) km in radius. There are 119 communities in Kumasi (Kumasi Metropolitan Assembly, 2014).

Kumasi is the most populated area in the Ashanti Region. According to the 2010 Population and Housing Census (PHC) it recorded a figure of 2,035,064, with yearly growth rate of 4.8 percent. At the end of 2013, the population of Kumasi had increased to 2,396,458. Almost 53 percent constituting majority of the population are less than 15 years whereas the rest of 47 percent are over 15 years. The Kumasi Metropolis has surface area of 254 square kilometers based on 2000 PHC, with a population density of 9,434 persons per square kilometer (Kumasi Metropolitan Assembly, 2014).



Source: www.googlemaps.com, 2017

Figure 3. Regional Map of Ghana showing the study area

Source: GSS (2014, p.3)

Figure 4. Map of Kumasi Metropolis

This section has explained the location, the estimated number of residents in the Metropolis and the population density, the next section will explain the social characteristic of Kumasi.

2.3.3. Social Infrastructure

The Kumasi Metropolitan Area has a range of facilities that provides social services to its people. Some of these facilities are healthcare, utility services (water supply, electricity etc.), to name a few (GSS, 2014, p.6).

2.3.3.1. Health

The metropolis has many health centers operated by both the public and private sectors. Among the most prominent is the Komfo Anokye Teaching Hospital (KATH), which is one of the two (2) independent national hospitals in Ghana, four (4) quasi health

institutions, five (5) health Care Centers belonged to religious organizations such as Seventh-Day Adventist Church and the Church of Christ. Additionally, there are more than two hundred (200) known private health institutions and 13 industrial clinics in the city. Also, "*there are 54 trained Traditional Birth Attendants (TBAs), nine (9) Maternal and Child Health (MCH) points and 169-outreach sites".* There are more than 25 Private Laboratories besides those Laboratories available in the various hospitals (Kumasi Metropolitan Assembly, 2016, p.5).

2.3.3.2. Utility Services

Barekese and Owabi water treatment plants are the main sources of safe drinking water supply for residents in Kumasi. Out of the 1000km network of water pipelines, Kumasi has 704 km for water transmission and distribution in the Ashanti Region. Despite this, some households have mounted mechanized boreholes with overhead poly tanks to supplement the safe drinking water supply by Ghana Urban Water Limited (GUWL).

The Kumasi's residents have access to power supply to facilitate their domestic and economic activities and this perhaps explain the presents of many industrial activities in the Metropolitan area (GSS, 2014, p.6).

Having explained some social features of Kumasi, the next section will explain environmental characteristics.

2.3.4. Environmental Characteristics

The Kumasi Metropolis is beset with several environmental challenges that include pollution of water bodies, inadequate waste management, air pollution, land degradation and so on (MESTI and TCPD, 2013, p.3-5).

2.3.4.1. Solid and Liquid Waste Management

Available statistics reveals that greater percentage (58.8 percent) of the households in Kumasi throws their solid waste into containers positions at public dumbing places. 15.6 percent uses open space as receptacle for solid waste. 17.2 percent of the households patronizes the services of Kumasi Metropolitan Assembly, and private solid waste collection company such as Zoomlion Ghana, and Royal Asadu to dispose of their

waste. Other approaches employs are burning (4.4 percent), indiscriminate disposal (1.9 percent), burying (1.6 percent) and others (0.4 percent).

In terms of liquid waste on the other hand, 35.9 percent of the households throws their liquid waste into gutters through drainage system. 32.2 percent report of disposing their liquid waste straight into gutters. Other methods used by households are: 15.4 percent throw onto compound, 7.8 percent onto street/outside, 5.0 through drainage system and through drainage into a pit/soak away system representing 3.5 percent (GSS, 2014, p.69).

The Ashanti Regional capital, Kumasi, has only one engineered landfill site located at Sakoban (Dompoase). The landfill acts as the final disposal site for the whole solid waste generated from the zone. For example, in the year 2009, Kumasi generated an average of 1,500 tons of solid waste per day, out of which 1,300 was collected. This means not all the generated waste end up in the landfill site as the remaining 200 tons find their ways in drains. A known example is the case of the drain close to Anloga junction which in recent time is gravely contaminated with solid waste (MESTI and TCPD, 2013).

2.3.5. Poverty

As said by the fourth Ghana Living Standards Survey (GLSS), overall incidence of poverty rate in Ghana has fell from 52 percent to 40 percent in 1991/92 and 1998/99, respectively. Statistics available suggests that approximately 2 million urban dwellers including Kumasi are categorized as poor, based on indicators not related to income such as health, education and housing (OCSD, 2005, p.13). Ghana is currently a middle-income status. Despite achieving the status of middle income, poverty seems to abound, especially in the Northern, Upper East and Upper West Regions of the country. It is estimated that 7 million Ghanaians, representing 28 percent of the country's population, are living under the poverty line of less than 2 United States Dollar per day (Ghana Web, 2013). In percentage terms, 23 percent of the population in Kumasi are employed by the industrial sectors while 72 percent sustain their livelihoods into the service sectors. (Kumasi Metropolitan Assembly, 2014). According to Development Plan for Kumasi Metropolitan Area (2010-2013), poverty level in the Metropolitan Area in the year 2000 was below 10 percent. However, urban poverty such as poor housing, non-

existent facilities, low level of literacy rate, poor sanitation, high unemployment and low incomes, emerges in the peri-urban and slum communities (MESTI and TCPD, 2013, p.3-21).

In short, the whole of this section has examined Ghana's political and administrative structure, location, demography, social, environmental characteristics of the study area and poverty situation. Kumasi being the Garden City of West Africa, there is a rapid spate of urbanization in the Metropolis culminating in the generation of various kinds of waste such as liquid and solid waste. In connection to this, it is therefore imperative to assess the sanitation system improvements in the Kumasi Metropolis from sustainability perspective.

The subsequent section will explain poor sanitation in the Kumasi Metropolitan Area.

2.4. POOR SANITATION IN THE KUMASI METROPOLITAN AREA (2008-2015)

The aim of this section is to present and analyze the data collected on sustainable sanitation criteria on the field by means of questionnaires, interviews, phone calls, email messages and documents reviewed. This section has been divided into four sub-groups: poor sanitation problem, existing sanitation management system, approach to sanitation and assessment of sustainability of sanitation system.

2.4.1. Poor Sanitation Problem in Kumasi

Clean sanitation is an essential element of human rights. However, many people in all parts of the world do not have access to improve and basic facilities of sanitation. This situation is not different from what is prevailing in Ghana including Kumasi. The year 2015 WHO/UNICEF global sanitation report claims that access to improve sanitation in Ghana is bleaker making the country ranked seventh as the dirtiest country globally as against tenth positioned in 2014, indicating the country seems not to pay keen attention to its sanitation sector, hence poor sanitation coverage (Graphic online Ghana, 2015). In 1990, when Ghana recorded seven percent in terms of sanitation coverage, Ethiopia had three percent. Today, Ethiopia has 28 percent coverage outstripping Ghana with only just 15 percent (Graphic online Ghana, 2015).

Moreover, in Ghana, 19 percent of its total population practices open defecation making the country placed second following Sudan in Africa (Ghana Web, 2015). Open defecation alone is causing Ghana a staggering 79 million USD per year but purging the menace would require construction of not more than 1 million latrines (WSP, 2012, p.1). That notwithstanding, it is estimated that 19,000 Ghanaians, including 5,100 children less than five years of age die annually, virtually 90 percent of which is directly linked to inadequate water, sanitation and hygiene (WSP, 2012, p.1). Similarly, in the mid of 2014 to January 2015, Ghana recorded nearly 28,922 cholera cases with 247 deaths, the highest number of cases for the past three decades in the annals of Ghana (MOH, 2014, p.37). This appears to underscore Ghana's lack of commitment to invest heavily in the sanitation sector to avert its dismal condition.

Provision of adequate sanitation facilities in the Kumasi Metropolis remain a major challenge to safeguard people's health by ensuring safety and hygienic environment. Majority of Kumasi's residents depend on public toilets, which are fraught with problems of bad stench, unhygienic environment, swarm of flies, lack of water and detergent to wash hands, lack of privacy, among others. The 2010 reported data by the Joint Monitoring Programme of UNICEF/WHO for Ghana states that as at 2008, 54 percent uses public/shared sanitation facilities (Kwaku, 2012, p.23). According to a Non-Governmental Organizations (NGO) in Kumasi, Water and Sanitation for the Urban Poor (WSUP), more than 40 percent of people in Kumasi depend on public toilets. There is only one public toilet for every 1095 people (WSUP, 2011, p.3). Children are prevented from using public toilet and their feces are all over the surrounding areas (Kumasi Metropolitan Assembly, 2003). This tend to suggest a significant percentage of those depending on the public toilets lack toilet on their own buildings. Per the WHO/UNICEF definition of improved sanitation, public or shared toilets are not considered as part of the components of improved sanitation because they are unhygienic (UNICEF and WHO, 2013, p.12; UNICEF and WHO, 2012, p.21).

Unhygienic pan or bucket toilets are still being use in Kumasi. They are discharged by unlicensed night-soil transporters, individuals who end up disposing the substances into river bodies and nearby bushes. Some landlords in the metropolis discharges their excreta directly into gutters or streams from connected water closets (Kumasi Metropolitan Assembly, 2003). The consequences of this action can only be imagined.

It is claimed that lack of adequate sanitation is having pernicious effects on public health as polluted water emanating from inadequate sanitation are used for domestic uses such as washing, drinking and bathing. High polluted streams also affect the survival of aquatic animals negatively.

Due to lack of adequate sanitation facilities in people's homes in the Kumasi Metropolis, it is common to see people waiting in queues particularly in the morning trying to have access to various public toilets facility dotted across the length and breadth of the city to ease themselves. Those having difficulties to spend time waiting either resort to unacceptable means or hold on until later time to relieve themselves when there is less pressure.

The inordinate delays in the released of District Assembly Common Funds to local government authorities in the country by the national government and inadequate revenue mobilizations at the local level among others, may be one major problem strangling the efforts of local authorities (Kumasi Metropolitan Assembly) to provide adequate sanitation facilities to prevent Kumasi dwellers from coming into close contact with feces, to avoid sanitation related diseases such as dysentery, cholera, diarrhea, schistosomiasis, typhoid fever, malaria. This seems to explain why Kumasi's population outraced provisions of sanitation infrastructure in the city (see figure 5 and figure 6 below). Figure 5 and figure 6 suggest provision of public toilet is not increasing in proportion to population growth in the Kumasi Metropolis. *"According to the Kumasi Metropolitan Assembly, the maximum capacity for one seat public toilet is 25 persons per day"* (Kwaku, 2012, p.55). Kwaku's surveys on hygienic practices at public toilets in Kumasi suggests an average of 59, 38 and 29 users per squat hole per day for Ayigya, Aboabo, and Manhyia, respectively. This suggests pressure on sanitation infrastructure in the metropolis and that likely to reduce its life expectancy. Again, according to Kumasi Metropolitan Assembly (2003), for the reason of high accommodation demands in some places in the metropolis, toilets and latrines are being renovated into sleeping rooms being renovated into sleeping rooms.

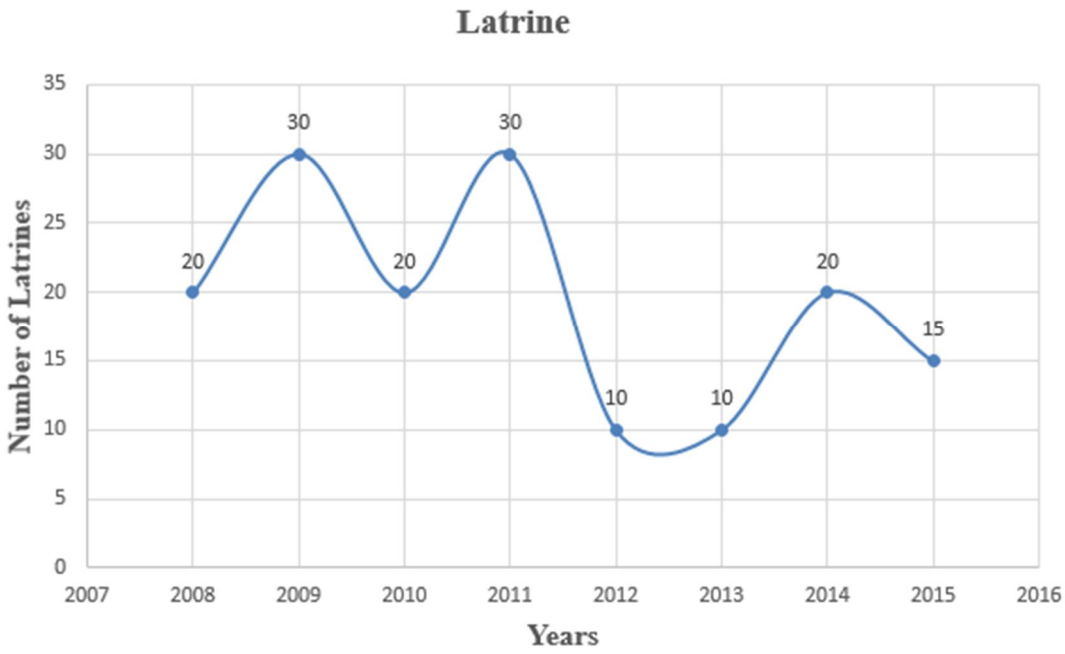


Figure 5. Number of Latrines Constructed at Public Places

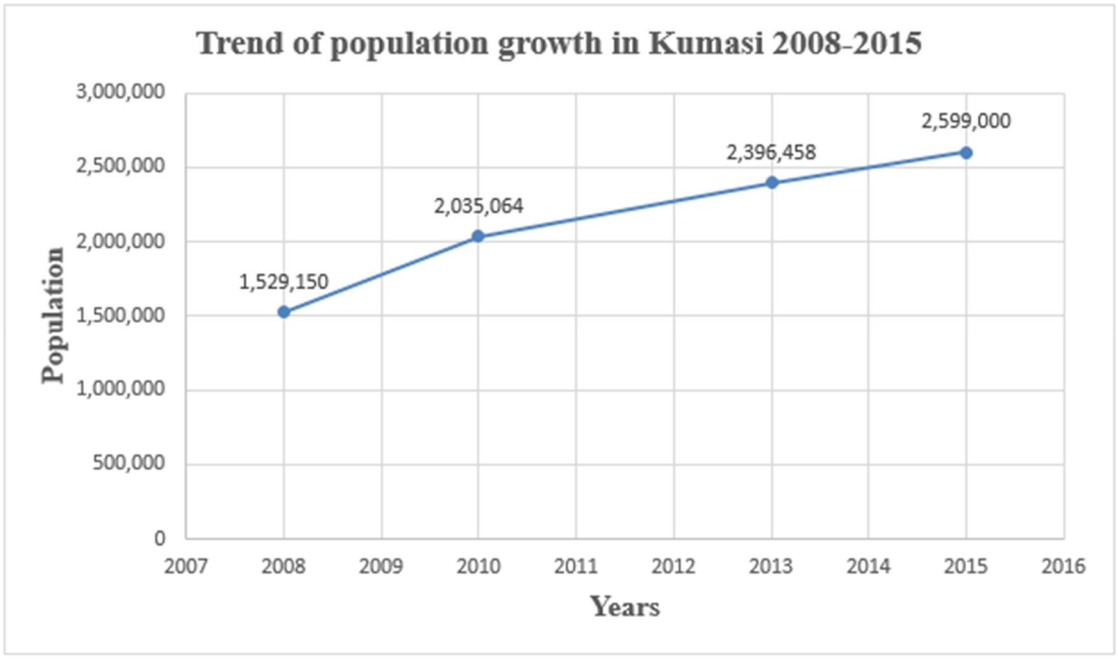


Figure 6. Trend of population growth in Kumasi between 2008 and 2015

Source: Kumasi Metropolitan Assembly, (2014, p.3), Maoulidi and Ibrahim, (2010, p.13), Index Mundi population, (2016).

This section has defined the problem of poor sanitation in the study area, Kumasi Metropolis, the next section will examine sanitation management system that exist in the Metropolis.

2.4.2. Existing Sanitation Management System in Kumasi

In Ghana, there are actors that are involved in the managements of sanitation both at the national and local level. At the national level includes Ministry of Local Government and Rural Development, Ministry of Sanitation and Water Resources, Ministry of Water Resources, Works and Housing (MWRWH), Ministry of Environment, Science and Technology, and Ministry of Health. At the levels of local governments are the MMDAs. Defining roles to actors in the discharge of performing their functions are key to improving sustainable sanitation. The following explain sanitation actors that are in place to curb sanitation menace in Ghana.

2.4.2.1. Ministry of Local Government and Rural Development

The Ministry of Local Government and Rural Development (MLGRD) is the lead agency charged with sanitation. The ministry is responsible for the co-ordination, formulation, monitoring and evaluation of the country's sanitation policy. The ministry gives out technical guidelines on management of sanitation systems, and promulgation of nationwide sanitation legislation and bye-laws including funds mobilization for sector plans and programs (MLGRD, 2010, p.23). In the MLGRD, there are Environmental Health and Sanitation Directorate (EHSD) and the Regional Environmental Health Offices that assist the duties of the ministry in sanitation. The EHSD provides technical assistance and has powers to control public and private sanitation service providers (MLGRD, 2010, p.24).

2.4.2.2. Ministry of Sanitation and Water Resources

With low improved sanitation coverage in Ghana (15 percent) coupled with poor sanitation ranking (second in terms of open defecation and seventh dirtiest country), many people, organizations are now elated as sanitation challenges are coming to an end when the country's president in the early 2017 dedicated a whole new ministry called

Sanitation and Water Resources Ministry. Organizations in the water and sanitation sector such as World Vision International-Ghana, WSUP-Ghana, CONIWAS, have hailed this recent development as an opportunity for efficient and effective harmonization and coordination in the water and sanitation sector. These organizations are very confident and optimistic that the newly formed ministry will be resourced adequately to achieve management of water and sustainable sanitation (World Vision-Ghana, 2017). Agencies such as EHSD, Community water and Sanitation Agency (CWSA), Water Directorates, that used to be under the MLGRD and MWRWH are now under the Ministry of Sanitation and Water Resources (ESPA, 2017). This means some functions of both the two ministries (MLGRD and MWRWH) have been taken away by the newly formed ministry. Creation of a ministry without accompanying financial resources may slow down the activities for which the ministry has been established to attain. The parliament of Ghana has earmarked an estimated amount of more than 255 million GHC to Sanitation and Water Resources Ministry, to provide adequate, safe, affordable improved sanitation and water (Online Today, 2017). This suggests political comittment by the president to address myriads of sanitation challenges in the country through the Ministry of Sanitation and Water Resources.

2.4.2.3. Metropolitan, Municipal and District Assemblies

The principal functions and aims according to the laws that set up the MMDAs in Ghana are to maintain high quality of community existence and uplift standards of living to significant levels to give respite to people of the communities (Mensah, 2005). One of the key functions of the MMDAs towards its objectives remains the provision of sanitation taking account of collection, solid, liquid wastes disposal in addition to cleansing of streets and drains around the Metropolis (Mensah, 2005). The Kumasi Metropolitan Assembly is the local government in Kumasi tasked to achieve this aim. In order to achieve this objective, it created the Waste Management Department (WMD) and Environmental Health and Management Departments (EHMD), and other units. The WMD of Kumasi Metropolitan Assembly oversee the construction and maintenance of sanitation facilities to prevent exposure of feces and urine through effective management of human excreta in the Metropolitan Area. EHMD is responsible for the inspection and implementation of sanitary guidelines, sanitation education to increase awareness on practices of hygiene and monitoring of sanitation facilities. They inspect

building plans of new buildings to make certain that they correspond to sanitary guidelines and upon approval, issue Habitation Certificate once the buildings are completed. Also, they periodically check buildings to ensure that the provisions of the appropriate laws and the building code are adhered to by occupants (MLGRD, 2010, p. 40).

2.4.2.4. Allied Actors and their Functions

The Ministry of Water Resources, Works and Housing (MWRWH) is the sector ministry in charge of policy formulation including provision of directions in respect to the preparation of plans and programmes in the infrastructure sub-sectors of water supply and sanitation, public works, housing, Hydrology and Flood Control Systems to ensure the sector efficiency (MWRWH, 2012, p.1). The sector also co-ordinate and supervise key agencies that fall under its ministry, namely Ghana Water Company Limited (GWCL), WRC and CWSA with the main aim of achieving set objectives by way of monitoring and evaluation (MWRWH, 2012, p.1).

The Ministry of Environment, Science and Technology (MEST) is another sector ministry in charge of environment. It is tasked with the policy formulation and coordination covering environment. MEST supports regulation in environmental sanitation and provision of manuals and technical standards for sustainable development (MLGRD, 2010, p.27). The ministry is functioning across the country through the Environmental Protection Agency (EPA). EPA monitors and enforces environmental activities. The EPA has local office in the Kumasi Metropolis that works closely with the Kumasi Metropolitan Assembly to ensure that environment and water bodies are not polluted with human waste (Thrift, 2007, p.14).

This Health Ministry together with the Ghana Health Service manages the health service sector, provides health data and education throughout Ghana. Also, they provide regulation and standard setting for purposes of health services. The sector uses data on sanitation to promote disease control and prevention (MLGRD, 2010, p.27).

2.4.2.5. Private Sectors

There are many private sectors that support in the provision of sanitation services in Ghana and the Kumasi Metropolis. Some of them are CONIWAS, Zoomlion Ghana, Clean Team Ghana, WSUP and Vacuum Tankers Operators.

CONIWAS is an association of 50 NGOs, private sector players and governmental agencies. They conduct policy dialogues that compose of discussions among all interested parties (market women, public office holders as well as traditional authorities) in water and sanitation. NGOs in the sanitation sector fall into four major groups by activity related. First, NGOs that deliver direct service like building of pit latrines to rural areas. Second, community institution building that encourages people's participation in tackling water and sanitation. For example, getting women involvement. Third, advocacy and finally, NGOs that do research and engages in capacity building (Thrift, 2007, p.15).

WMD within MMDAs may deliver sanitation services to private contractors or by franchisees (MLGRD, 2010, p.24). WMD of Kumasi Metropolitan Assembly has contracted Zoomlion Ghana and other companies in the management of waste. Zoomlion offers services especially door to door collection of solid waste. Clean Team Ghana is an NGO that provides affordable container toilet to low income communities. Furthermore, WMD of Kumasi Metropolitan Assembly is in collaboration with WSUP to provide compound toilets to compound houses for individuals, landlords, with flexible terms of payment to reduce dependency on public toilets. Vacuum Tankers Operators dislodge fecal materials from individual homes, houses and taken to the landfill site at Dompoase for treatment (Personal Communication, 2015).

2.4.3. Approach to Sanitation in Kumasi

The following explain the official approach to sanitation in the Kumasi Metropolitan Area.

In Ghana, Asare (2015, p.30) identifies that awareness of EcoSan is very minimal. To Thrift (2007, p.15), only a few organizations are involved in ecological sanitation in the country. Some of the renowned projects in the country comprises the ecologically

designed Valley View University campus in Dodowa, Accra, a biogas project in Kumasi constructed by an organization, Friends for Mentally Handicapped Children, a fecal sludge composting plant, Accra, co-composting of waste including waste water irrigated agriculture in Buobai, Kumasi, by non-profit research organization called International Water Management Institute (IMWI).

In Ghana's Environmental Sanitation Policy, approaches for management of excreta are forward thinking and move beyond containment as all wastes are considered as a resource (MLGRD, 2010). Ekuful (2010, p.XI) argues that stakeholders in Ghana including Kumasi understand that EcoSan is an effective approach to reduce waste generation, but the principal challenges impeding in promoting the EcoSan concept stem from underfunding, lack of implementation guidelines and insufficient awareness. The researcher interaction with Public Health Officer of Kumasi Metropolitan Assembly of the WMD suggests that the assembly have not reached the stage where human waste could be recycled even though there are initiatives in place. He further indicates that Zoomlion Ghana, a private waste management company, has a facility to recycle waste but even the facility is not functioning.

This entire section has examined the existing sanitation management system, and approach to sanitation approach in Kumasi, the following section will conduct an assessment of sustainability of sanitation system in the Kumasi Metropolis.

2.4.4. Assessment of Sustainability of Sanitation System in Kumasi

There are several ways to measure sustainability of sanitation system using different criteria. This study measures improvements of sustainability of sanitation system in Kumasi using the criteria: health, environment, technical, and financial and economic.To do the measurements by presenting statistical data, the past and today's condition of sanitation management in the city is explained.

In the past, households were generating closed to 25,000-meter cube of human waste each month together with flush water for water closets. However, only closed to 10 percent of it is dispose of from the city. The remaining, 90 percent, is left in the urban environment for decomposition to take place. Then conveyed away by small streams or

drainage ditches, or dries and develop into airborne (Whittington; Lauria; Wright et al, 1993, p.77).

Presently, it is assessed that approximately 90 percent of Kumasi's residents employ the services rendered by vacuum tankers otherwise called motorized emptying, either tacitly through public toilets or directly by households having their compounds toilets or residential homes emptied. It has been assessed that about 95 percent of the collected waste is carried to the fecal sludge treatment plant (WEDC, 2015, p.23). Manual emptying also exists in the metropolis (WEDC, 2015, p.23-24). Despite huge percentage of the collected waste are taking to a treatment facility, recent report suggests that, unbearable pungent smells emitting from Dompoase Landfill site, where both solid and liquid waste from Kumasi are dumped, are forcing people to move away from their homes. People have built houses around the site but they cannot stay owing to daily stench that fills the air. Inhabitants around communities closed to the landfill have organized series of demonstrations to ventilate their concerns but they ended up being beaten by security personnel (Joy FM, 2017). Fecal wastes from the Dompoase landfill site, Kumasi, are allowed to flow freely into gutters especially when it rains. Black flies associated with poor sanitary conditions are all over due to irregular maintenance of the landfill site. According to one resident the stench is akin to dead animals at the back of their houses (Joy FM, 2017).

2.4.4.1. Health

Sustainable sanitation systems must protect human health and prevent diseases. There are many ways to measure health criteria using different variables. This study measures health criteria using the variables, number of diseases related to sanitation and deaths because of inadequate sanitation.

2.4.4.1.1. Number of Sanitation Related Diseases

There are many sanitation diseases associated with poor sanitation management. This study uses typhoid, intestinal worm, schistosomiasis, cholera, diarrhea and malaria disease cases to assess health criteria due to inadequate sanitation in Kumasi Metropolis. To Ekuful (2010, p.76), the umpteen challenges in Ghana's sanitation sector

is leading to the epidemics of diseases in the country such as diarrhea, cholera, typhoid fever, intestinal worms and malaria.

Crump; Luby; Mintz, (2003, p.347) in their study "Global Burden of Typhoid Fever" use the following standard to assess level of incidence (prevalence) of typhoid fever in Africa, Asia, Europe, Latin America and Oceania. The standard is as follows:

High (>100 per 100,000 per year),

Medium (10-100 per 100,000 cases per year),

Low (<10 per 100,000 cases per year)

The same standard is adopted in this research study to determine level of improvements of sanitation system in the Kumasi Metropolis in terms of health variable: number of reported cases of diseases associated with poor sanitation. To ascertain its improvement or otherwise based on the standard, the total number of reported cases is divided by total population multiply by 100,000 (Crump; Luby; Mintz, 2003, p.350). The population of Kumasi as at the year 2015 was about 2,599,000 and this is used as total population in calculating number of cases per 100,000 people per year.

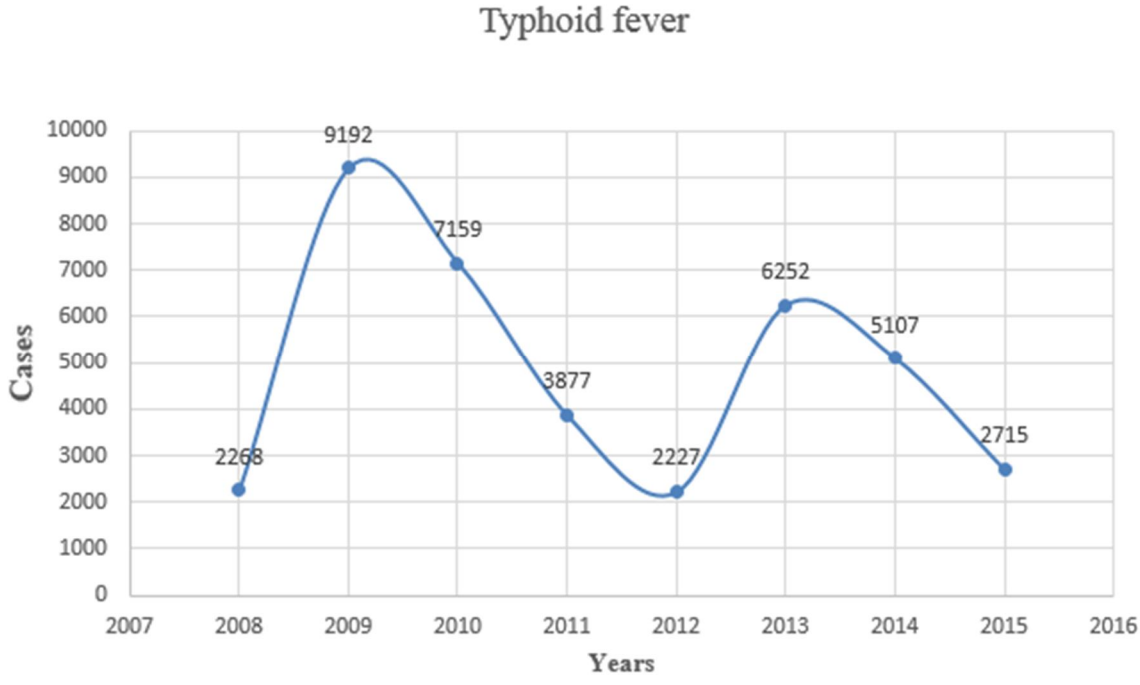


Figure 7. Number of Reported Cases of Typhoid Fever

This graph (figure 7) gives information about typhoid fever cases reported in the Kumasi Metropolitan Area for the years from 2008 and till 2015. From the graph, at the start of 2008, the number of typhoid fever cases reported was 2,268. These cases sharply climbed to precisely 9,192 in 2009. However, from 2009 to 2012, the total of typhoid recorded slumped by 6,965, it went up again to 6,252 in the year 2013 and finally declined to 2,715 in 2015. As an overall trend, it can clearly be seen that the graph rose and fell throughout the period under study. Whilst 2009 recorded the maximum typhoid fever cases (9,192), the year 2012 was undoubtedly the minimum (2,227). The total number of typhoid cases in the Kumasi Metropolis from 2008 to 2015 was 38,797. This implies that around 4,850 cases averagely were reported yearly. The rate of typhoid in the metropolis is 186.60 per 100,000 cases per year, which is greater than 100 per 100,000 cases per year, implying that typhoid cases are high in Kumasi. To Crump et al (2004, p.346), regions with high occurrence of typhoid are South-central Asia, South-East Asia. Regions with medium incidence include Africa, Latin America, Caribbean, Oceania and the rest of Asia. Europe and North American as well as other developed world are the regions with low incidence, because they all recorded less than 10 per 100,000 cases per year. This analysis then appears to demonstrate insignificant improvements in the management of sanitation system as far as the Kumasi Metropolis is concerned.

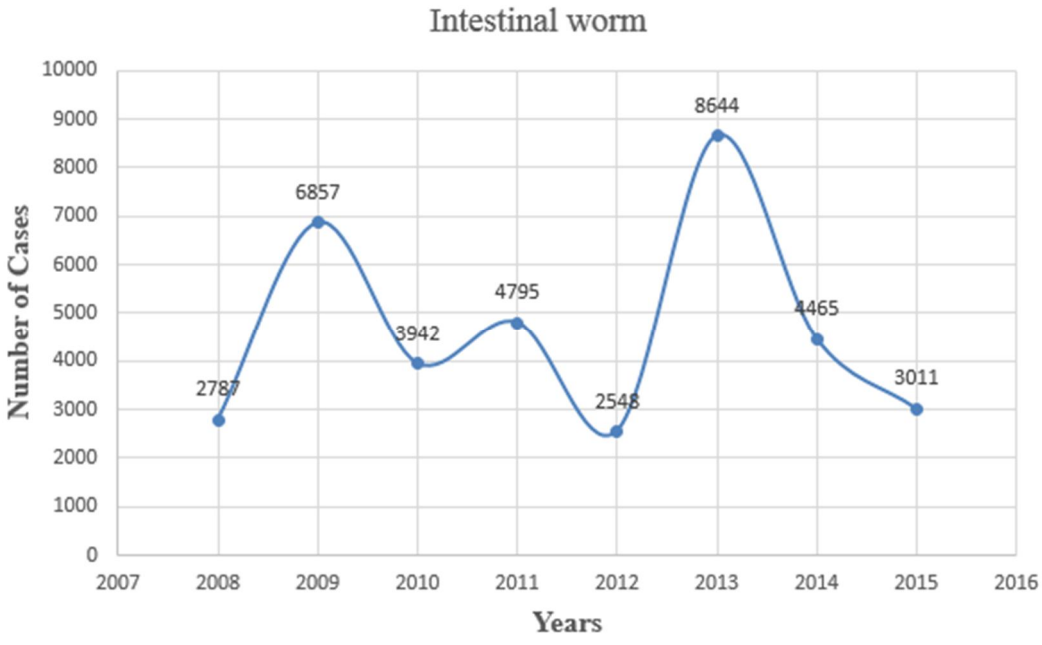


Figure 8. Number of Reported Cases of Intestinal Worms

The provided line graph (figure 8) represents changes in the number of intestinal worms recorded within the city of Kumasi due to poor sanitation and hygiene over an eight-year period. We can see from the graph that, at the beginning of 2008, the total number of patients who suffered from this disease was 2,787. This number soared to 6,857 in 2009. Invariably, from 2008 to 2009, there was a growth in intestinal worms cases by 4,070 cases. Within four years, 2009 to 2012, the disease dropped significantly from 6,857 to 2,548. It increased to 8,644 in 2013. The number decreased to 4,465 in 2014 and continue to fall to 3,011 at the end of the year. The average reported patient yearly was 4,631. It is immediately evident that among these eight-year period, while 2013 reported the largest cases, 2012 witnessed the smallest. Crump; Luby; Mintz, (2003) suggest that, a country that recorded more than 100 per 100,000 cases of disease annually is endemic. This could be attributed to lack of adequate sanitation facilities. In Kumasi, intestinal worms cases are high because it recorded 178.19 per 100,000 cases per year. Based on this comparison, sanitation system improvements in Kumasi could be described as ineffective.

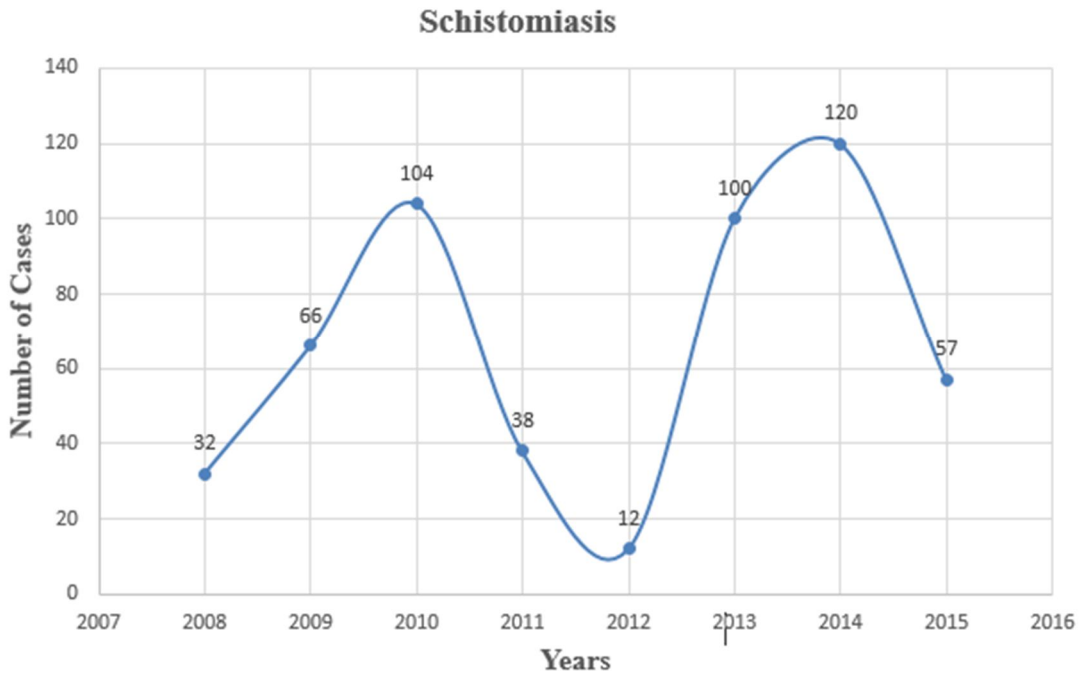


Figure 9. Number of Reported Cases of Schistosomiasis

The provided diagram (figure 9) illustrates the amount of cases of schistosomiasis reported within the urban Kumasi over an eight-year period. The diagram shows that from 2008 to 2010, there was a significant rise in the number of schistosomiasis

reported cases from 32 to 104. This figure then dropped dramatically to 12 cases in 2012, the least recorded throughout the entire period, and rose to 100 in 2013, continue to increase to 120 cases in 2014, the maximum point under the whole study period and then dropped as low as 57 cases at the end of 2015. In sum, the noticeable trend of schistosomiasis was not stable, it oscillated from the start of the year to the end of the 2015. The number of schistosomiasis reported in eight years was 529. On average, 66 cases of schistosomiasis were reported annually. The reported cases of schistosomiasis in the Kumasi Metropolis are low. This is because it recorded 2.54 per 100,000 cases per year. The above analysis suggests improvement in the sanitation systems management in Kumasi.

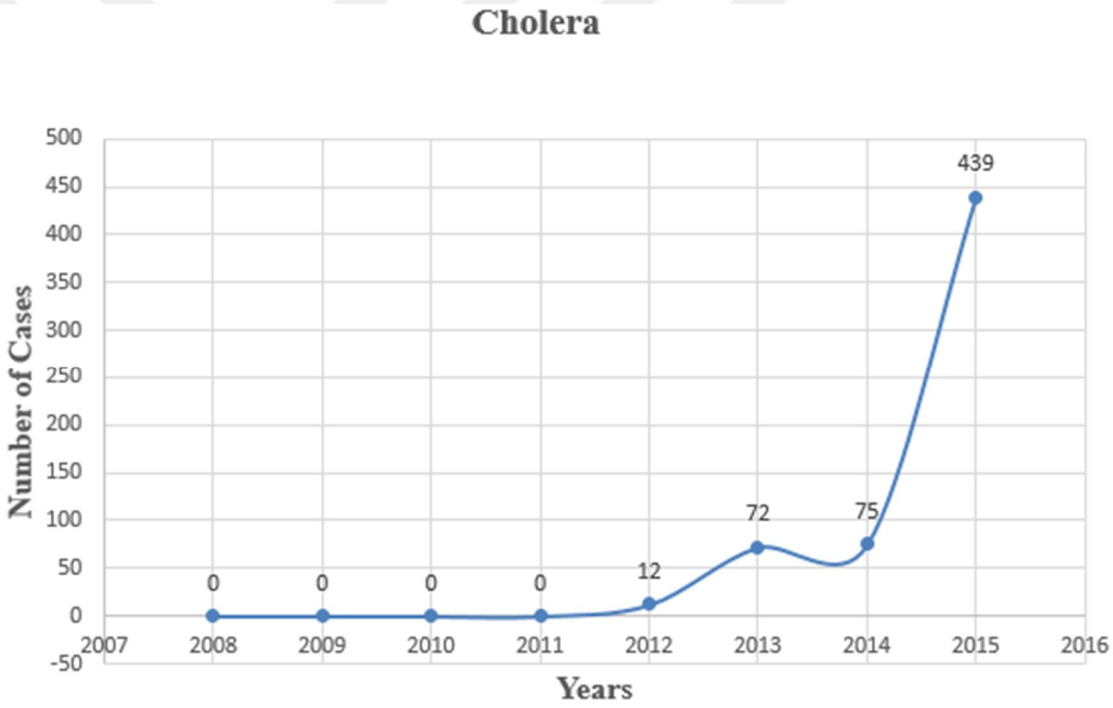


Figure 10. Number of Reported Cases of Cholera

This graph (figure 10) shows the number of reported cases of cholera in Kumasi, the capital of Ashanti Region, Ghana, between 2008 to 2015. The year from 2008 to 2011 based on the graph, recorded zero cases of cholera (remained constant within four years), then there was a significant surged in the number of cholera cases reported from 12 in 2012 to 439 in 2015. The mean of cholera reported per year was almost 75 cases. A total of 958 cases of cholera was reported throughout the years under study. Generally, it is evident that the graph demonstrates an upward trend throughout the

years. Cholera recorded 2.89 per 100,000 cases per year, which is far less than 10 per 100,000 cases per year. Again, this is suggesting an improvements of sanitation systems in the Kumasi Metropolis.

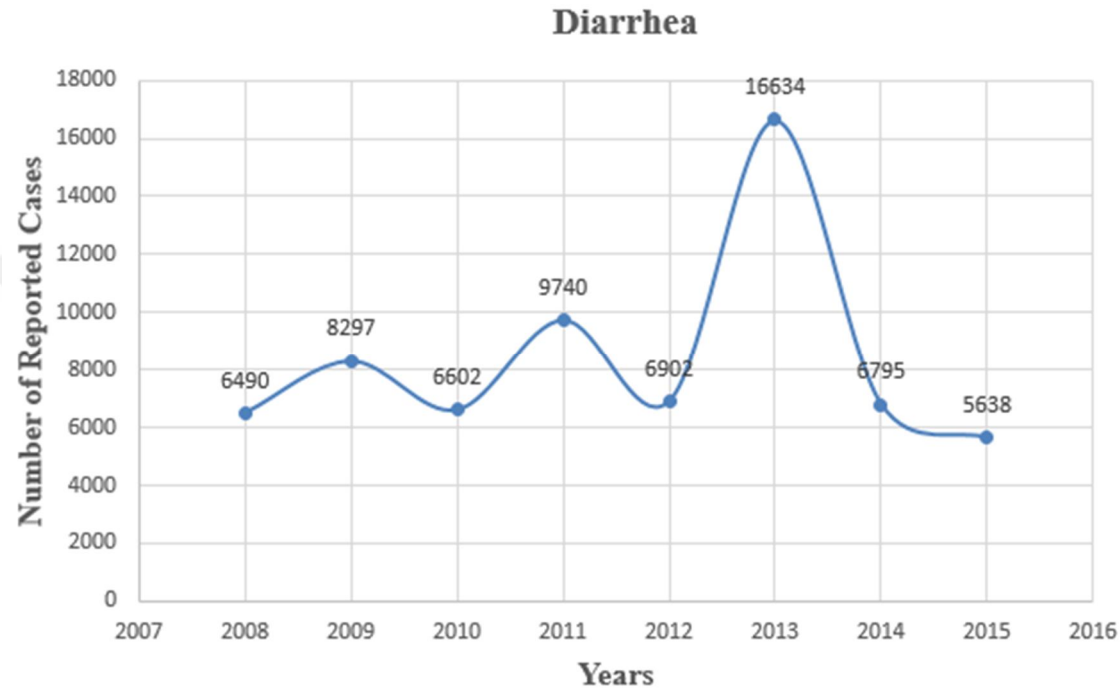


Figure 11. Number of Reported Cases of Diarrhea

The given graph (figure 11) depicts number of cases of diarrhea reported within Kumasi between 2008 and 2015. According to the information in this graph, the number of diarrhea cases began at 6,490 in 2008. This number appreciated to 8,297 in 2009. From this time, the cases of reported diarrhea in Kumasi came down to 6,902 at the end of the 2012. There was a rapid surged of this disease from 6,902 in 2012 to 16,634 in 2013, and subsequently witnessed a downward trend to 5,638 in 2015. In general, the cases of diarrhea rose till 2013 and dropped down afterwards. Between 2008 and 2015, around 67,098 diarrhea cases were reported in Kumasi, with an average of over 8,000 diarrhea disease cases annually. The number of diarrhea recorded in Kumasi was 322.71 per 100,000 cases per year, greater than 100 per 100,000 cases annually. Largely, this could then be explained that, improvement in the sanitation system in the metropolis is ineffective.

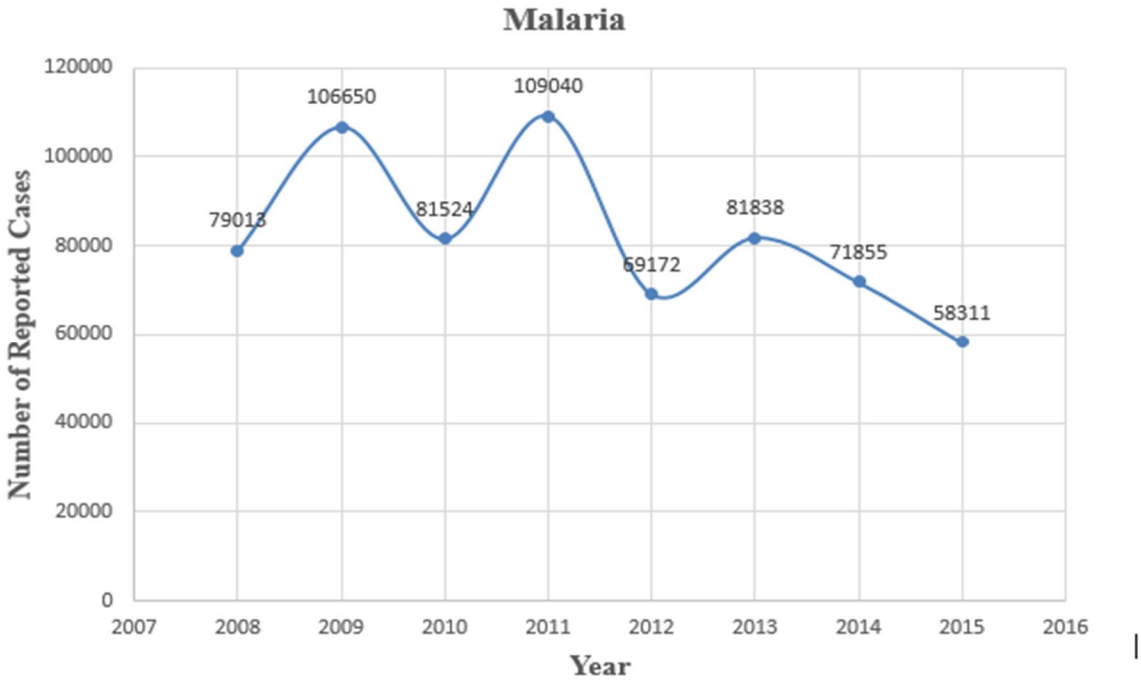


Figure 12. Number of Reported Cases of Malaria

The above graph (figure 12) demonstrates the changes in reported cases of malaria in Kumasi, the Ghana's second largest city, from 2008 to 2015. According to the graph, the number of malaria reported in 2008 was 79,013, increased rapidly to 106,650 cases in 2009. From a total of 81,524 in the year 2010, the number jumped to 109,040 in 2011, the highest cases among the years under study. From that point, the figure of malaria declined to almost by half 58,311 by the end of 2015, the lowest cases reported. Overall, it can be observed that malaria reported cases fluctuated throughout the eight-year period. On average, 82,175 malaria cases were reported in Kumasi per year, and the highest among all the diseases reviewed. About 657,403 of malaria cases were reported in the Kumasi Metropolitan Area throughout the eight-year period from 2008 to 2015. Again, 3,161.81 per 100,000 cases of malaria per year were recorded. This analysis suggests extremely little improvements in Kumasi's sanitation system.

From the analyses presented above on the number of sanitation related diseases, it is cleared that schistosomiasis and cholera recorded as low as 2.54 cases per 100,000 and 2.89 cases per 100, 000 people per year, respectively. These figures are less than the standard of 10 cases per 100,000 people per year. In contrast, typhoid, intestinal worms, diarrhea as well as malaria because of inadequate sanitation recorded figures greater

than Crump; Luby; Mintz, (2003) yardstick of 100 cases per 100,000. Consequently, it can then be deduced that there are slights improvements in the system of sanitation management in Kumasi from the standpoint of sustainability.

The number of reported cases of diseases related to inadequate sanitation is discussed, the following section will discuss number of deaths reported in Kumasi.

2.4.4.1.2. Number of Death Related to Sanitation

This section sought to explain the number of deaths attributable to poor sanitation. The number of deaths related to malaria, number of deaths related to cholera and number of deaths related to typhoid are presented below. To ascertain whether the number of deaths related to these diseases are in line with international standards or not, a case fatality rate is used. Case Fatality Rate (CFR) basically is the proportion of people who die of a disease out of the reported cases or who contracted it. The CFR for cholera should remain below 1 percent (WHO, 2017). Acceptable level of CFR for cholera and typhoid is 1 percent or lower (Sphere project, no date). Malaria level should be less than 5 percent. Mathematically, CFR is the total number of deaths divided by the total number of reported cases and multiply the answer by 100 (IDSR, 2010, p.96).

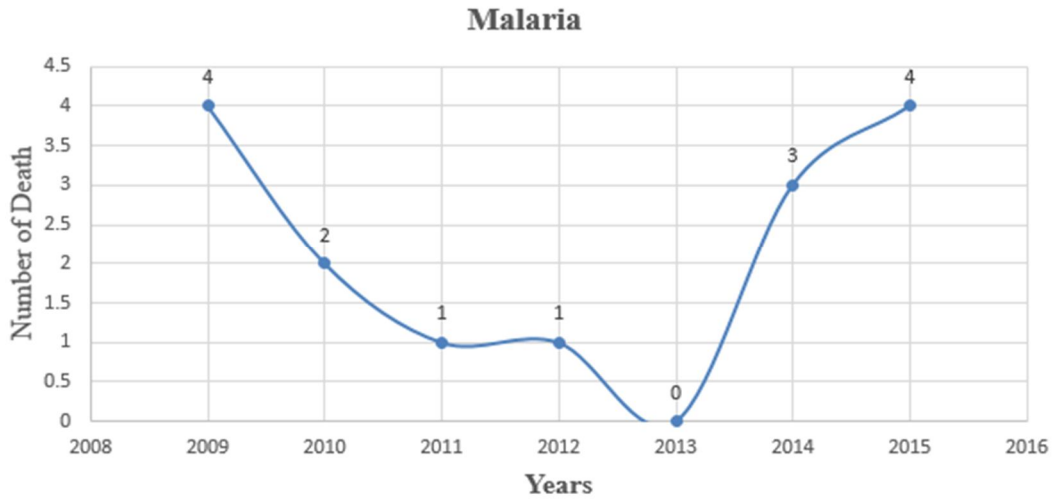


Figure 13. Reported Cases of Malaria Death

The graph above (figure 13) shows the number of malaria deaths reported in Kumasi. In 2009, Kumasi recorded 4 deaths and proceeded to fall to zero (no death was recorded)

in year 2013. Nonetheless, malaria deaths climbed to 4 by the end of 2015. A total of 15 deaths and 657,403 cases were recorded within the years reviewed. Therefore, malaria case fatality was 0 percent, which is below acceptable level of 5 percent. This analysis seems to demonstrate health care service improvements in Kumasi.

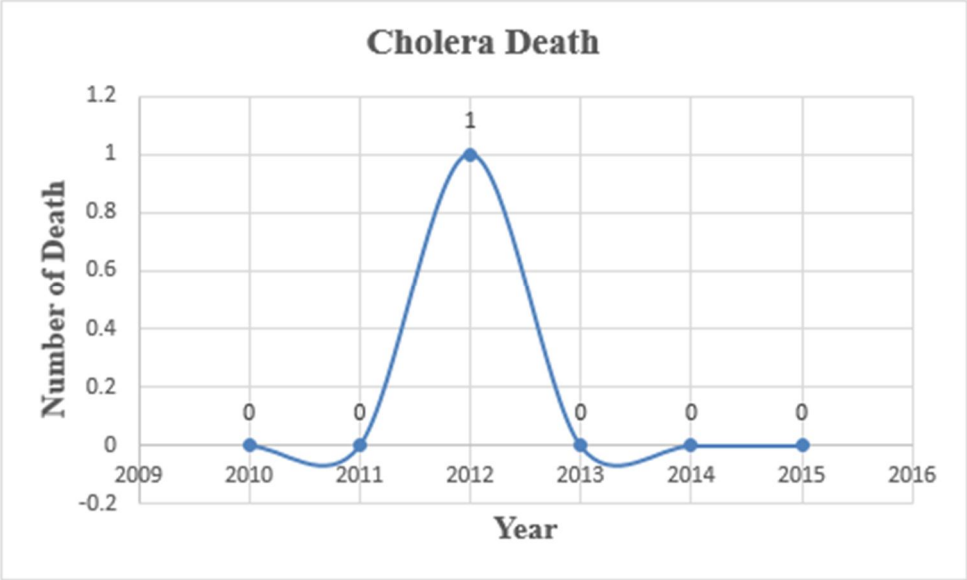


Figure 14. Reported Cases of Cholera Death

The figure 14 shows the changes in the number of cholera deaths in Kumasi. Cholera death experienced an upward trend from 2010 to 2012. The trend nonetheless changed and from 2012 there has been a downward movement from 1 death to no death recorded till 2015. A total of 1 death was recorded. As indicated above, a total of 598 cases of cholera was reported in the Kumasi Metropolis. Therefore, cholera case fatality is 0.17 percent, which is below 1 percent. This analysis also seems to indicate improvements in the health care service in the metropolis.

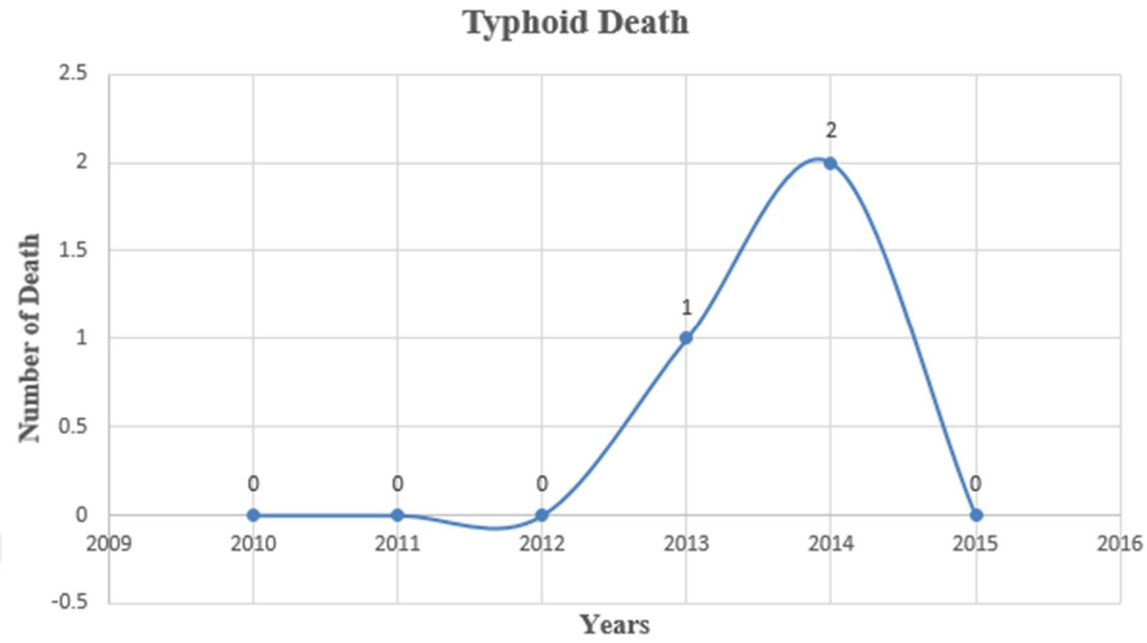


Figure 15. Reported Cases of Typhoid Death

It can be observed from the above line graph (figure 15) that the number of typhoid death reported in urban Kumasi experienced an upward movement from zero or no death in three consecutive years (2010-2012) to 3 deaths reported in 2013 and 2014. The trend alternatively varied and beyond 2014 there has been no death at the end of 2015. As stated above, 38,797 cases of typhoid were recorded in the urban area. Consequently, cases fatality rate for typhoid fever was 0.1 percent. This analysis appears to demonstrate better improvements in health service delivery in the Kumasi Metropolis. As displayed on the graphs number of death connected to inadequate sanitation, the number of reported cases of diseases are high but number of death is very low. One possible explanation could be attributed to better provision of health services in Kumasi.

In this section, the number of reported deaths related to sanitation is discussed, the section that follow will discuss environmental variable; level of BOD in Subin River.

2.4.4.2. Environment

Sustainable sanitation systems should not contribute to environmental pollution. There are numerous ways that can be used to measure environmental criteria. This study

measures environmental criteria using the variable, the amount of biological oxygen demand per liter in Subin River due to lack of adequate sanitation.

The study chooses Subin River because it flows through the Kumasi Central Business District where it encounters human activities, hence generates all kinds of waste including liquid waste, and finally ends up at Owabi river, the second primary source of drinking water for inhabitants in Kumasi, Ashanti Region, and other neighborhoods (Personal Communication, 2015).

BOD is one of the widely-used measurement of water quality, and represents the amount of oxygen required for the microbial decomposition of the organic matter in the water. The BOD method is broadly used in monitoring quality of water and biodegradation of waste materials (Nimo 2006, p.38-39). It is calculated to establish how much oxygen micro-organisms consumed during oxidation of the organic matter existing in the sample. High levels of BOD decrease the levels of dissolved oxygen because the available oxygen in the water is being consumed by the bacteria. Given that less dissolved oxygen is available in the water, fish and other aquatic organisms may struggle to survive (No name, no date).

The quality of water bodies, which was previously considered fairly good, has now been showing indications of gradual deterioration. Water pollution of various levels is prevalent in nearly all the river basins of Ghana nonetheless very much evident in urbanized river basins (MWRWH, 2010, p.28). One of such rivers is Subin River located in urban Kumasi.

Significant amounts of industrial effluents, spillage and leachates end up in Subin, Abaobab and Sisa Rivers without treatment (Maoulidi, 2010, p.21). Untreated discharge of domestic waste water has resulted in serious pollution of Subin water (Pagett and Acquah, 2012, p.4). Water resources in recent years have come under a great deal of danger from human activities in the urban environment as their security appears to be ignored by the people as well as the responsible outfits (Ahmed and Dinye, 2012, p.249). Indiscriminate disposal of waste such as liquid waste in the Subin, Wiwi as rivers have impacted adversely on the drainage systems and so have brought these rivers to the brink of extinction, consequently causes flooding (Campion, 2012, p.51).

Though number of factors could affect supply of drinking water to consumers, deterioration of water bodies also cannot be overlooked because huge amount of money is required to treat polluted water before distribution. Available statistics demonstrates that in the Ashanti Region together with Kumasi, there is a gap of over 52, 000 out of daily water demand of 162,829m3/day against daily quantity water supply of 110,345m3/day (MWRWH, 2010, p.40).

According to Minister of Water Resources, Works and Housing, cost of treating polluted river bodies in Ghana increased from 11,272,000 GHC in 2011 to 21,733,000 GHC in 2012. An increase of almost 10,461,000 GHC. This increased amount could have been spent to provide adequate drinking water for the populace if river bodies are free from waste discharges (Ghana News Agency, 2012). Also, Owusu-Sekyere; Aasoglenang; Bonye, (2014, p.9) report that urban households in Ghana do not have regular flowing of water through their taps from the GWCL, therefore have to complement their limited supply with water from sources for instance rivers and Wells. They observe, the quantity of water available including Subin water is decreasing, the quality is being compromised mainly owing to high population growth. Increase in population, particularly in urban areas generates both solid and liquid waste which finally destroy drinking water sources.

Adombire et al., (2013, p.33) claims, lack of provision of simple waste disposal and sanitary facilities in many settlements has prompted contamination of streams and waterways. The River Subin standouts amongst the most undermined by growing cities and industrial effluent discharge. Dissolved Oxygen concentration in the Subin River has decreased below acceptable thresholds. The river to some extends is viewed as "lifeless" which on all the time deoxygenated. Because of direct waste discharges into the Subin River, high levels of fecal coliform ranging between 21 x 10^3 counts /100ml and 44 x 10^{11} counts/100ml have been reported (WRC Ghana, 2012, p.19). Finally, in their study, Asare-Donkor; Wemegah; Adimado, (2013, p.44) reveal that the Sisa, Wiwi and Subin Rivers are heavily polluted and not suitable for household activities, irrigation purposes and aquatic existence.

The data obtained from the secondary sources reveals that water quality of Subin River is contaminated. This implies that BOD in the Subin River is excessive and excessive

BOD decreases dissolved oxgen which eventually makes living uneasy for marine organisms. This may be due to lack of adequate supply of sanitation infrastructure and population growths.

2.4.4.3. Technical

Sustainable sanitation systems should be technically appropriate for the society. Despite many ways to measure technical criteria, this study measures the robustness of sanitation technology; pit latrine and public toilet.

There are several sanitation management systems used in both the developed and developing countries. These sanitation management systems are the centralized and decentralized sanitation. In Kumasi Metropolitan Area, Ghana, decentralized sanitation is the system designed to overcome poor sanitation problems. It is alternatively called on-site management. This system stores fecal matter on-site in a pit latrines or septic tanks, emptied frequently, subsequently transport to treatment plant (Hawkins; Blackett; Heymans, 2013a, p.3). Technology options for the management of sanitation on-site in the metropolis are the aqua privy, bucket/pan latrine, Kumasi Ventilated Improved Pit latrine, water closet and pit latrine. A mere 5 percent in the city is connected to sewerage system (GSS, 2010). Ahinsan, Asafo and Chirapatre are the only three communities in the Kumasi Metropolis connected to sewerage networks. Waste water coming from toilets are taken away by water pipes to waste stabilization ponds (Personal Communication, 2015).

Robustness of these sanitation technologies are central to the prevention of sanitation diseases. Technologies must be hygienic/clean, attractive, accessible, safe and users must have confident on the sanitation technologies without thinking of infections. The following explains robustness of pit latrine and public toilet.

2.4.4.3.1. Robustness of Pit Latrine

Pit latrines are the most common sanitation technology for disposal of human excreta in Sub-Sahara Africa countries including Ghana (Graham and Polizzotto, 2013, p.521; Kjellén; Pensulo; Nordqvist et al, 2011, p.19). An estimate of around 1.77 billion people in the world use pit latrines as their basic means of excreta disposal. This number is expected to rise as populations surge and countries aims to meet the MDGs connected to

sanitation (Graham and Polizzotto, 2013, p.528). In Ghana, according to the 2010 PHC, roughly 19 percent relies on pit latrines. A recent study undertaken by Asiedu in one of the districts in Ashanti Region, Offinso South shows, an overwhelming majority of 80 percent of the households use pit latrines outside their abodes (Asiedu, 2012, p.3). Adubofour; Obiri-Danso; Quansah, (2012, p.199) also in a survey in two urban slum communities in the Kumasi Metropolitan Area; Aboabo and Asawasi, show 27 percent in Aboabo uses pit latrine whilst in Asawasi 28 percent uses the same type of sanitation technology.

Boots (2008, p.4) asserts, pit latrine does not require water to function, thus suitable for areas with lack of adequate water supply. Cost of pit latrine construction is low, so low-income earners could be able to afford. Again, it allows different kinds of anal cleansing materials. Mate (no date, p.4) contends, in a well-constructed, well maintained and properly used pit latrine, human excreta are disposed of safely, in so doing reducing environmental contamination, infection diseases and these will contribute meaningfully to public health. Additionally, well maintained and constructed pit latrine toilet with 3 meters deep could be used for more than decade by a family of six before the pit gets full.

On the contrary, in a study by Katukiza; Ronteltap; Niwagaba et al, (2012), they find that pit latrines are the dominant type of excreta disposal facilities in urban slums in Africa and Ghana. Nonetheless, it is difficult to operate them sustainably. The reason is at the backdrop that pit latrines contaminate drinking water sources and management of fecal sludge is inadequate. Frank (2010, p.iv) analysis of pit latrines on ground water in Tano District of Brong Ahafo Region of Ghana indicates that pit latrines have profound impact on quality of ground water, hence prevalence of diarrhea disease in the district. A research undertaken by Odai and Dugbantey in Ghana (no date, p.14-73) admit, pit latrine is a major potential source of ground water pollution, but the levels of pollution in ground water source hinge on distance between the pit latrines and the ground water supplies. More so, the study shows that pollution levels depend on soil types.

Tsinda; Abbott; Pedley et al, (2013, p.6951) and Kayetesi (2008) in their studies find that pit latrines are the primary means of excreta management systems that exist in Kigali, Ruwanda. Tsinda; Abbott; Pedley et al, (2013, p.6951) aptly stress that this system is not an option to sustainable sanitation, because they are susceptible to

leakages, collapse during torrential rainfall and attract flies. Moreover, this facility due to small volumetric capacity for most of pits it fills up quickly due to many users and not easy to empty regularly.

To Herron (2011, p.61), the health problems created by pit latrines have been broadly documented. The defecation hole invites flies and mosquitoes and produces a terrible odor. Often, pit latrines serve as breeding grounds for mosquitoes, leading to increasing and spreading the incidence of malaria.

2.4.4.3.2. Robustness of Public Toilet

Ghana has made enormous investments in public latrines because public toilets are the main facilities upon which poor people heavily depend (Oduro-Kwarteng; Awuah; Nyarko, 2009, p.7; Thrift, 2008, p.6). In Ghana, 54 percent uses shared sanitation facilities as at the year 2008 according to Joint Monitoring Programme of UNICEF/WHO 2010 report (Kwaku, 2012, p.23). Ghana's 2010 PHC put the figure reliant on public toilets at 32 percent (GSS, 2013, p.46). WSUP (2011, p.3) claims, over 40 percent of residents in the Kumasi Metropolis uses public toilets. WSUP maintains that there is one public toilet for every 1,095 inhabitants.

Public toilets that are being used comprise different forms of sanitation technology. These are flush toilets with septic tanks connected to soakaways, Enviro Loos, Kumasi Ventilated Improved Pits (KVIPS), aqua privies etc. (WEDC, 2015). The quality of sanitation facilities is currently getting better due to involvement of private sector and the elimination of dry technologies by Kumasi Metropolitan Assembly (WEDC, 2015).

Many research studies on public toilets have been done. Allen et al, (2008) claim that public toilets provide some considerable services to portion of the population. Nevertheless, this type of sanitation in general due to inadequate maintenance does not meet the hygienic requirements of women and children.

Peprah; Baker; Moe; et al, (2015, p.602) in their study in Accra, Ghana, identify that cost and cleanliness are factors that discourage public toilets use, contributing to the menace of open defecation. According to them, public toilet users recommended more construction of toilets, improvements in hygiene, and provision of water and soap for handwashing as ways to improve toilets situation. This is consistent with what Oduro-

Kwarteng; Awuah; Nyarko, (2009, p.7) report in Kumasi, majority of households that use public toilets are dissatisfied with the odor and cleanliness level.

Kwaku (2012, p.V) also agrees that hygiene standard at all public toilets he studied in Ayigya, Aboabo, Manhyia, all suburbs of Kumasi, are very low with fecal matter and waste papers on toilet floors. Waste baskets has no cover and hardly to empty, causing spillover of waste papers. Resulting from lack of adequate management, nearly all public toilets in these three areas smell bad causing users to take away their clothes before gaining access to them. He observes that waiting in long queues to gain access to public toilets is a normal feature for the most part of the toilets. This is clear in the mornings from the hours of 06:00 to 8:00 GMT and evenings from 18:00 to 19:00 hours GMT. These times witnessed lot of pressures on the public toilets making them unhygienic and situating users at risk of disease infections (Kwaku, 2012, p.52). Public toilets facilities are opened between 5 am and 10 pm but there are queues at peak periods between 5.30 and 6.30 am (WEDC, 2015).

Lastly, there are 359 functioning public toilets covering 5,792 toilet cubicles in Kumasi (WEDC, 2015, p.20). Averagely, there are 16 toilet cubicles (16 toilet holes) in each toilet. *According to the Kumasi Metropolitan Assembly, the maximum capacity for one seat public toilet is 25 persons each day* (Kwaku, 2012, p.55). Mathematically, maximum of 403 persons are expected to use one public toilet per day. As pointed out above, one public toilet exists for every 1,095 persons. This could probably explain the long queues as well as the pressures reported at various public toilet facilities in Kumasi Metropolis.

The data obtained from the secondary sources indicates that sanitation technologies in Africa and in Kumasi, Ghana, have some defects like unpleasant odor, not appropriate for human health and environment. This may be as a result of inefficient management of pit latrine and public toilet. But at same time they provide privacy for those using them.

This section has discussed robustness of sanitation technology, next section will discuss financial and economic criteria.

2.4.4.4. Financial and economic

Sustainable sanitation system should ensure that there is appropriate investment in sanitation management. There are number of ways to measure financial and economic criteria with different variables. In this research study, financial and economic criteria are measured in terms of the amount of money earmarked to sanitation management in Kumasi and cost of construction of household toilets.

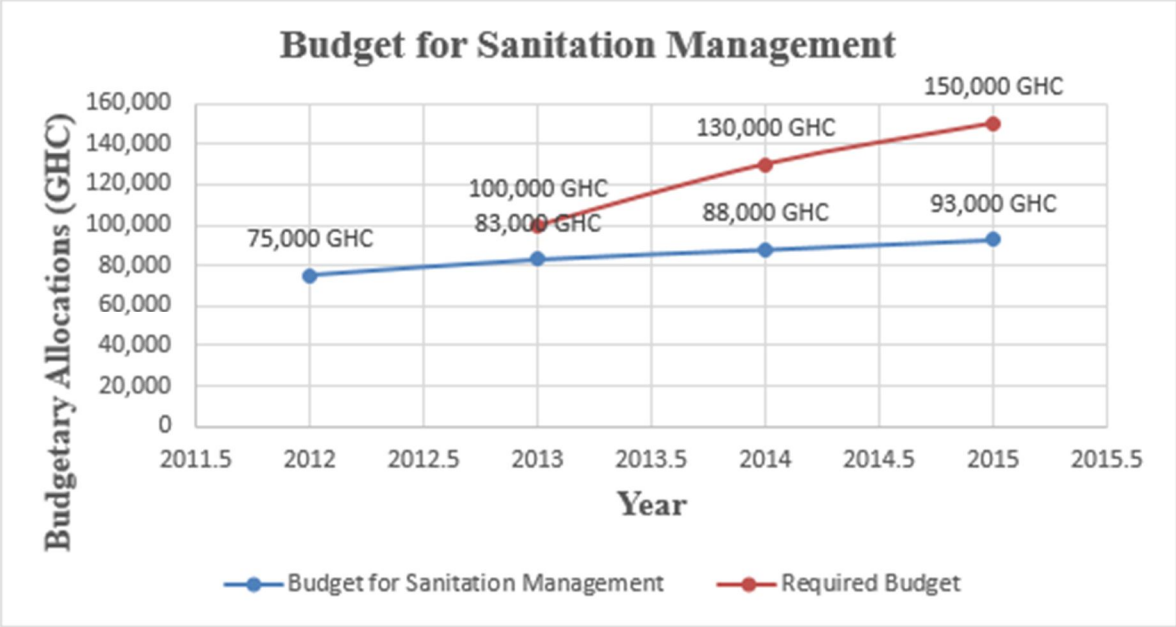


Figure 16. Budgetary Allocations to Sanitation Management

The graph (figure 16) provides information about the required budget and amount of money earmarked for management of sanitation in the Kumasi Metropolis, for maintenance of stabilization ponds and provisions of public toilet. It is cleared from the graph that budgetary allocated to sanitation management went up over the period 2012-2015. From 75,000 GHC in 2012, the money assigned to improve sanitation in the metropolis increased to 93,000 GHC in the year 2015.

Similar to bugetary allocated to sanitation management, the required budget was also increasing yearly after yearly as can be seen in figure 16. It rose from 100,000 GHC in 2013 to 130,000 GHC in 2014 and to 150,000 GHC in 2015. Comparing the two line graphs of budgetary allocated and the required budget, there is a gap of 17,000 GHC, 42,000 GHC and 57,000 GHC in 2013, 2014 and 2015, respectively.

This analysis demonstrates insufficient allocation of financial resources to undertake maintenace of stabilization ponds and provisions of public toilet, mainly because of low revenue mobilizations at the local level as well as delays in the release of District Assembly Common Fund by the Ghana Government. [Bank of Ghana Exchange Rate (14.06.2017) 1USD=4.33-4.34GHC].

The above section has discussed amount earmarked for sanitation management (budgetary allocations to sanitation management), the section below will discuss cost of construction of household toilets.

Financial and economic in the case of household toilets construction cost, sustainable sanitation should be affordable for households. This study uses VIP latrine despite numerous available sanitation technologies. VIP latrine includes one of the technologies households, communities are encouraged to construct in Ghana (Personal Communication, 2017). Besides, it reduces unpleasant smells. It attracts and exterminate flies that causes uncomfortable to users (Herron, 2011, p.61). VIP latrine is cheap, easy to maintain and different cleansing materials; solid and water can be used. (Kayatesi, 2008, p.98).

The cost of building VIP toilet from 2012 to 2015 is estimated by calculating 2016 cost (3,810 GHC provided by WasteCare Associates) using yearly inflation rate recorded in Ghana (8.7 percent in 2011, 9.2 percent in 2012, 8.3 percent in 2013 and 15.5 percent in 2014) (Focus Economics, 2015).

It is claimed that inability of people to afford basic sanitation facility because of inadequate income contributes to the challenges of wiping out poor sanitation not only in Ghana but also across developing economies. Affordability is relative. It varies from individuals to individuals and to geographical locations. This study views affordability or otherwise of cost of household toilets construction from the angle of Ghana's minimum wage (the least amount of salary that employers are expected to pay employees for the work done).

Figure 17. Cost of Constructing Household Toilets

This graph (figure 17) describes variations in the cost of household toilets construction. The year from 2012 to 2013 based on the graph increased from 3,479 to 3,498 GHC, then there was a decreased to 3,464 GHC in the following year and increased again to 3,738 GHC by the end of 2015. Generally, the cost of latrine construction shows an increase over the years. Now, Employment and Labor Relations Ministry in 2012, 2013, 2014 and 2015 pegged Ghana's daily minimum wage at 4.48 GHC, 5.24 GHC, 6 GHC and 7 GHC, respectively (Wage Indicator, 2017). That is, yearly minimum wage in 2012 was around 1,452 GHC, 2013 was 1,698 GHC, 2014 was 1,944 GHC and finally 2015 was 2,268 GHC. Average yearly minimum wage from 2012 to 2015 was closed to 1,841 GHC whereas average cost of building household latrines within the same years was 3,545 GHC. Meanwhile, mean household expenditure in Ghana is 9,317 translating into an average expenditure of around 26GHC daily per person (GSS, 2014, p.135). In respect of this, it could be argued that an average person would face much difficulties in meeting daily minimum living standard not even to think about toilet construction. This therefore suggests high cost of providing toilet facility by households based on average minimum income. [Bank of Ghana Exchange Rate (14.06.2017) 1USD=4.33-4.34GHC].

Taken financial and economic as a whole, there is a yawning gap between amount earmarked and the required budget to manage sanitation in Kumasi Metropolis. Furthermore, cost of putting up toilet facility by citizens in Ghana and Kumasi is expensive (on average 3,545 GHC from 2012-2015) comparatively to the country minimum wage (roughly 1,841 GHC between 2012-2015). It is therefore logic to infer that, there are some complexities in financing sanitation management to sustainability.

2.5. DISCUSSION

Although provisions of adequate sanitation are crucial for the development of general well-being, the empirical evidence presented in this chapter has shown that sanitation in Kumasi tends to be poorly managed which may have negative ramifications for residents in the metropolis and far afield. For instance, the unstable trend of diseases reported cases like diarrhea, intestinal worms, schistosomiasis, etc. are due to ineffective sanitation management. The management of sanitation in the Kumasi Metropolis was assessed in terms of some selected sustainable sanitation criteria. Major findings are discussed below.

Sustainable sanitation should protect public health. Regarding health criterion, the study examines number of reported cases of diseases and death as a result of inadequate sanitation. The diseases are typhoid fever, intestinal worms, schistosomiasis, cholera, diarrhea as well as malaria. The study finds that apart from cholera which experienced an increase from 2008 to 2015, the other diseases reported cases fluctuated throughout the years. In addition, the study reveals that, on average, malaria recorded the highest reported cases (82,175) follows by diarrhea (8,387), typhoid fever (4,850), intestinal worms (4,631), cholera (75) and schistosomiasis (66). According to Ghana Health Service (2010, p.13), malaria has been the leading cause of outpatient attendance at medical facilities in Ashanti Region including Kumasi. Malaria alone accounted for almost 50 percent of the total patient attendance. This agrees with what Orji; Okoli; Ezenwaji (2015, p.7) reported, in Onitsha, Nigeria, malaria recorded the highest occurrence (average of 14,070) among diarrhea, dysentery and typhoid studied from 2011-2014. In the capital of Cote d'Ivoire, Yamoussoukro, the situation is no exception as 30,247 malaria cases were the highest reported in 2012 due to poor sanitation facility follow by diarrhea (3,444) and the least recorded was typhoid fever (206) (Kouamé;

Dongo; Viet Hung et al, 2014, p.10305). The study again finds that, the number of reported cases of malaria, diarrhea, typhoid and intestinal worms have not met Crump et al, (2003) standard of number of disease cases per 100,000 people. Only cholera and schistosomiasis meet the standard.

With number of deaths recorded within the metropolis, cholera and typhoid have met WHO case fatality rate standard which is 1 percent or below. Similarly, number of malaria deaths have also met the acceptable threshold of below 5 percent. The study once again suggests the number of all the disease cases reported are on the high-level but reported number of death because of sanitation is very minimal. This is could be attributed to improvements in Ghana's healthcare service including Kumasi.

Pertaining to environment, sustainable sanitation should not contaminate or pollute river bodies. First, the study shows that hitherto quality of rivers in Ghana together with Subin River is quite good. However, the condition of the river bodies particularly in urban areas like Kumasi is changing that requires appropriate attention. The study suggests that River Subin is not just a river but source of river that contribute to Kumasi second primary source of drinking water supply. Again, it suggests waste water far from treatment are released not only in Subin River but also some other rivers that are within Kumasi. Cost of water treatment in Ghana including Subin River is going up which affects daily water supply. Finding of the study finally shows, the Subin River is contaminated, meaning BOD in River Subin is high, high level of BOD reduces dissolve oxygen, making it inappropriate for domestic activities and marine living. Population explosion, lack of adequate sanitation facility are attributed to ravaging quality of Subin River. As argue by WEDC (2015, p.12), growing population will result to an upsurge in open defecation due to inadequate sanitation facilities.

Concerning technical, this study reveals that pit latrines are used in Africa, Ghana including Kumasi to solve open defecation. Pit latrines sometimes could not stand with harsh weather condition, they are open to leakages, therefore pose risk to ground water. The risk to ground water may mean pit latrine construction designs are not adhered to or they are badly maintained. Finding of the research further highlights that this sanitation technology is apt for communities without constant flow of water. It is inexpensive to

build and use. These positive features may explain reasons for widely use of pit latrines around the world especially in developing countries.

With regard to robustness of public toilet, demand for public toilets in Ghana had decreased by 22 percent between 2008 and 2010 but its use in the country seems to be on the high side. In Kumasi for instance, about 40 percent use public toilets (Salifu, 2013, p.8). Public toilets that provide a place for convenience to majority of people in the Kumasi Metropolis include aqua privies, Enviro Loos, flush toilet connection with septic tank and so on. Public toilets in Ghana and Kumasi receive little attention in terms of proper care and management to the satisfaction of users. Most of them are unhygienic, have offensive smells, which forces the populace to resort to open defecation. Like Oyinloye and Oluwadare's (2015) study, over 83 percent of public toilets users in Agege, Lagos-Nigeria, expressed unhappy about its condition. They complained of bad odor and dirty environment. Public toilets in the Kumasi Metropolis are insufficient, that is the number of users exceed available toilet facilities in the metropolis, causing lengthy queues. It also implies more pressure on the few facilities may shorten its life spans. This study further shows that public toilet in the metropolis cannot be accessed beyond 10 pm. This finding supports O'Keef; Christoph; Kamara et al, (2015) which indicate, public toilets in both Nairobi (Kenya) and Kampala (Uganda) are difficult to access at night.

In regard to the financial and economic, the research study measure variables; amount of money earmarked for sanitation management (budget for sanitation management) and cost of construction of household toilets.

With the amount earmarked for sanitation management, the study finds that whereas budget allocated to sanitation system management such as maintenance of stabilization ponds and provisions of public toilet increases from 75,000 GHC in 2012 to 93,000 in 2015, required budget also experiences an upward trend from 100,000 GHC to 130,000 GHC in 2012 and 2015, respectively. Despite these increases, finding from the study reveals that the financial resources provided to improve sanitation system in Kumasi Metropolis is inadequate. The gap that existed between money earmarked/budgetary allocated and required budget in fighting the scourge of poor sanitation is soaring. In 2013 for example, 17,000 GHC gap existed, it jumps to 42,000 GHC in 2014, then to 57,000 GHC in 2015. This finding is in line with Tsinda; Abbott; Pedley et al, (2013,

p.6949) who argue that sanitation situation could be improved towards sustainability if financial resources are available to national and local government authorities. In conjunt ion with Keita (2017), funding gaps and delays of resources allocated by the national governement to local governements prevent them from operations costs and maintenance of sanitation infrastructure at their respective local areas.

On the cost of constructing household toilets (that is, VIP toilet), affordability is important in improving sanitation coverage. People regardless of their status in a country especially those living in penury should be able to afford basic sanitation facility. In the case of Ghana and Kumasi, finding of the research study suggests that both the annual minimum income and VIP latrine construction cost generally are increasing on yearly basis. The problem however is that average VIP latrine building cost (3,545 GHC) is more than the average minimum earning in Ghana (1,841 GHC). This implies that the cost of acquiring household toilets based on the country's average earning is expensive to an average individual in Ghana and Kumasi. This possibly will explain the reason for low sanitation coverage in Ghana (15 percent). Research finding by Tsinda; Abbott; Pedley et al, (2013, p.6939) point that the main impediment to improved sanitation in Kigali, Rwanda, is cost. According to Oduro-Kwarteng; Awuah; Nyarko (2009), the main factors for lack of improved home toilets in Kumasi are poverty, high cost of construction coupled with lack of space in most of houses. Additionally, Adubofour; Obiri-Danso; Quansah (2012, p.199) analysis of sanitation in Aboabo and Asawasi in Kumasi also reveals, the households low incomes also deter them from owning private latrines.

On balance, the study per the analysis presented above in terms of sustainability suggests marginal improvements of sanitation system as far as health, environment, technical, and financial and economic criteria are concerned. The research suggests high number of reported cases of diseases with low death, pollution of water sources, unhygienic of sanitation technology, high cost of constructing home toilets, and inadequate financial support. Admittedly, this is an incomplete assessment of sanitation in Kumasi, therefore other criteria, indicators, variables may produce contradictory result.

CONCLUSION AND RECOMMENDATIONS

This chapter aims to summarize how the research question was answered. It summarizes the main findings of the research study, implications of the findings and recommendations.

CONCLUSION

This study seeks to answer the research question how much improvements have been achieved in the sanitation systems of Kumasi Metropolitan Area, Ghana, from 2008 to 2015 from the perspective of sustainability. The research question is answered by identifying some selected criteria, indicators and variables that data can be obtained to achieve the objective of the present study. The criteria identified are health, environment, technical, and financial and economic with variables; reported number of diseases and deaths linked to lack of adequate sanitation, level of BOD in water resources (Subin River), robustness of sanitation technology, amount of money assigned to management of sanitation and cost of constructing household toilets, respectively. This assessment is not comprehensive. It is a restricted assessment, so use of other criteria, indicators, variables may yield different result.

Data that were collected to realize the objective were both from primary and secondary sources. The primary data was sourced from several institutions, namely Tafo Government Hospital, South Suntreso Government Hospital, Department of Waste Management, Clean Team Ghana etc. This is through the form of interview to key informants, phone calls and email messages by employing the technique of purpose sampling. Then descriptive statistics were used to analyze the variables exclusively for health, and financial and economic (see their variables above).

Without benchmark, it is somewhat difficult to assess the progress of water and sanitation sector. Therefore, this study depends on public health standard, financial standard (budget allocated against reguired budget), cost of household toilets construction against Ghana's minimum wage, to measure against the data gathered on

the field on health, and financial and economic variables to determine its sustainability. On the other hand, secondary sources of data such as journal articles, dissertations, reports among others were also used to analyze environmental and technical variables.

The major findings of the research are as follows:

On health, the study finds that diarrhea, malaria, typhoid as well as intestinal worms reported at health centers fall below acceptable standard whereas cholera and schistosomiasis meet with set standard. Furthermore, malaria deaths, typhoid and cholera deaths reveal acceptance tolerance level. This analysis denotes slight sanitation system improvements in Kumasi from the standpoint of sustainability.

Relating to environment, the finding of the study highlights that Subin River is contaminated to the extent that it cannot support aquatic life and domestic purposes like drinking, washing and cooking, mainly because of high levels of BOD. This denotes slight improvements of sanitation system from view point of sustainable sanitation.

On technical, the finding of the study indicates some number of residents in Kumasi, Ghana, use pit latrines as a means to get rid of their waste rather than resorting to open defecation. Pit latrines seem like not to be robust as they are likely to collapse during heavy rainfall, contamination of ground water as a result of vulnerable to leakages. Public toilets on the other hand, are patronized by large proportion of Kumasi residents. Public toilets are untidy, have obnoxious smells, inadequate causesing long queues, and so on. This again shows very little improvements as far as Kumasi's system of sanitation is concerned from the sustainable perspective.

Lastly, involving financial and economic, the finding suggests that the financial resources apportion to management of sanitation are insufficient to address poor sanitation by building public toilets and maintenance of stabilization ponds. In other words, there is mismatch between budgetary allocated and required budget. The finding again hints that putting up household sanitation facility like construction of VIP toilet in Ghana and in Kumasi Metropolis is unaffordable to an average citizens as far as the country's yearly minimum wage is concerned. In terms of sustainability, sanitation system management in the Kumasi Metropolis indicates a very modest improvement.

The implications of the above findings are summarized below:

Theory and practice of sustainable sanitation is constantly evolving. This study presents a partial assessment of sanitation in Kumasi in terms of sustainable sanitation. Theory developers, researchers, policy makers and practitioners can make use of findings of this research to challenge the problems of sustainable sanitation.

RECOMMENDATIONS

From the findings, the study proposes recommendations for practitioners and policy makers of how poor sanitation in Kumasi could be solved as well as recommendation for future research.

Recommendations for practitioners and policy makers:

1. The study recommends construction of centralized system of sanitation to cover entire communities in the Kumasi Metropolitan Area. This should accompany with effective and adequate provision of maintenance to prevent people from contracting diseases which sometimes causes deaths.

2. Environmental Protection Agency should ensure that waste water are treated to acceptable standards before effluents are discharged into water bodies.

3. Kumasi Metropolitan Assembly besides local revenue mobilizations must seek financial support from donor institutions and agencies to shore up its funding gap.

4. Governmet should come up with policies and programmes that would ensure sound management of the country's economy to reduce inflationary rate to the barest minimum, which in turn would reduce the cost of goods and services in the country including the cost and materials of constructing household latrines.

Recommendation for future research:

This research study is limited to Kumasi Metropolis, Ashanti Region, due to paucity of time, scanty financial resources, to name a few. This suggests the findings of the study cannot be generalized completely to cover Metropolitan Areas in Ghana. To determine

the findings applicability in different regions in Ghana, future research could be done in different areas in different regions in the country. What is more, apart from the variables this study concentrated on to ascertain the sanitation system improvements of Kumasi, different study should focus on other variables of sustainable sanitation criteria, for example, number of households with toilet, number of households without toilet in addition to amount of money government spends to control sanitation diseases etc.

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APPENDICES

T.C
ERCİYES ÜNİVERSİTESİ
Sosyal Bilimler Enstitüsü
Siyaset Bilimi ve Kamu Yönetimi Anabilim Dalı
Başkanlığı

27th October 2015

To Whom It May Concern,

I write to introduce Mr. Ibrahim Basiru who is a student of mine at the Department of Political Science and Public Administration, Erciyes University, Kayseri, Turkey.

Mr. Basiru is pursuing a study leading to the award of Master degree in Political Science and Public Administration.

Having completed his one year of course work, Mr. Basiru is now conducting research on sanitation in Ghana titled "Towards Sustainable Sanitation: The Case Study of Kumasi Metropolitan Area Between 2007-2014".

As an important aspect of this exercise he needs to collect information by visiting a number of public and private agencies in order to interview various persons and to examine some documents relevant to his research. I hope you may assist Mr. Basiru in doing his research. The information provided to him will be kept strictly confidential, and will be used for academic purposes only. Any assistance given to him in data collection is highly appreciated.

Thank you in advance for your kind assistance and cooperation.

Sincerely,

Mustafa Demirci, PhD
Associate Professor
Department of Political Science and Public Administration
Erciyes University

Kayseri

TURKEY.

CURRICULUM VITAE

PERSONAL INFORMATION

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EDUCATION

Level	Institution	Date of Graduation
Master Degree	Erciyes University, Inst. of Social Sciences	2017
Undergraduate Degree	University of Ghana, Faculty of Social Sciences	2011
High School	T.I. Ahmadiyya Senior Secondary School	2005

WORK EXPERIENCE

Year	Institution	Duty
February 2013-August 2013	Samsung Ghana Limited, Kumasi	Field Marketer
October 2011-August 2012	Afrangua D/A Pry School, Central Region	Teaching-Nat'l Service
July 2011-September 2011	Regional Coordination Council, Kumasi	Internship
June 2010-July 2010	Ghana Cocoa Board, Kumasi	Internship

FOREIGN LANGUAGES

English, Turkish