Biomedical Pollutants and Urban Waste Management in the Accra Metropolitan Area, Ghana: A Framework for Urban Management of the Environment (FUME)

by

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AUTHOR'S DECLARATION

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners. I understand that my thesis may be made electronically available to the public.

Abstract

Ecosystems provide essential necessities required for the sustenance of life including food, water, medicine, aesthetics, recreational and spiritual outlets. Preserving and maintaining the integrity, carrying capacity, diversity and functions of ecosystems is therefore necessary for sustainability. Naturally, ecosystems are resilient and have the ability to bend and flex with various stressors while retaining their integrity, provided the challenges are not overwhelming. On the other hand, consistent mismanagement can result in the transformation of pulse disturbances into chronic and compounded perturbations. Ultimately, this can result in the dilapidation, alteration and in some case, removal of ecosystems. In many developing countries, ineffective management of urban wastes contributes to the magnification of risks to ecosystems and public health. Particularly perturbing is the mismanagement of biomedical pollutants generated during the course of healthcare activities. Biomedical wastes are known to contain infectious, toxic and radioactive substances that carry a greater risk for the environment and public health than regular urban wastes. In spite of the risk factors, mismanagement of biomedical pollutants is widespread in many developing countries.

Predicated primarily on post-positivist epistemology, this case study research investigated systemic and institutional arrangements pertaining to the management of urban wastes including biomedical pollutants in the Accra Metropolitan Area (AMA), Ghana. The research uncovered major deficiencies in management of urban wastes and biomedical pollutants which contributes to elevated risks to the environment and public health. The underlying causes of the problems were found to be embedded in deficiencies relating to weak governance, feckless regulations, resource constraints, corruption, technological limitations, service delivery and a general lack of awareness. As part of the research, an eclectic Framework for Urban Management of the Environment (FUME) was developed to address gaps in existing environmental planning and decision-making approaches. The FUME model consists of salient features of the precautionary principle, ecosystem approach, adaptive management, co-management, environmental risk management and integrated waste management.

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Dedication

This thesis is dedicated to my two wonderful children, Seaenna and Marlee! You are my inspiration!!!!!

"Life is one big road with lots of signs, so when you're riding through the ruts, don't complicate your mind. Flee from hate, mischief and jealousy, don't bury your thoughts, put your visions to reality"

– Bob Marley, Wake Up and Live, *Survival*. 1973

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List of Abbreviations

ADB	African Development Bank
AMA	Accra Metropolitan Area
BMW	Biomedical Waste
CSA	Canadian Standards Association
CCME	Canadian Council of Ministers of the Environment
CCC	Centralized Container Collection
CBD	Convention on Biological Diversity
DA	District Assembly
DACF	District Assemblies Common Fund
EFW	Energy from Waste
EHMD	Environmental Health and Management Department
EPA	Environmental Protection Agency
EPC	Environmental Protection Council
EPR	Extended Producer Responsibility
FDA	French Development Agency
FUME	Framework for Urban Management of the Environment
GDP	Gross Domestic Product
GHS	Ghana Health Services
GARCC	Greater Accra Regional Coordinating Council
I C& I	Industrial, Commercial and Institutional
IGR	Internally Generated Revenue
IWM	Integrated waste management
LCA	Life Cycle Analysis
MCE	Metropolitan Chief Executive
MFA	Ministry of Food and Agriculture
MOH	Ministry of Health
MLGRD	Ministry of Local Government and Rural Development
MEST	Ministry of Environment, Science and Technology

MSW	Municipal Solid Waste
NEAP	National Environmental Action Plan
NEP	National Environmental Policy
OECD	Organization for Economic Cooperation and Development
OECD	Organization for Economic Cooperation and Development
PAH	Poly-nuclear Aromatic Hydrocarbons
PCB	Polychlorinated biphenyls
PCDF	Polychlorinated dibenzo-furans
PCDD	Polychlorinated dibenzo-para-dioxins
PhAC	Pharmaceutically Active Compounds
PPP	Polluter-Pays-Principle
PSP	Private Sector Participation
RCM	Rational-Comprehensive Model
RTOS	Return to Original Supplier
UN	United Nations
UNEP	United Nations Education Program
UNGA	United Nations General Assembly
UNESCO	United Nations Education, Scientific and Cultural Organization

Chapter 1
Introduction

1.1 Introduction/Problem Background

Ecosystems[1] provide essential necessities required for the sustenance of life including food, water, medicine, aesthetics as well as recreational and spiritual outlets. Preserving and maintaining the integrity, carrying capacity, diversity and functions of ecosystems is therefore necessary for sustainability. It is worth emphasizing that ecosystems are naturally resilient and have the ability to bend and flex with various stressors while retaining their integrity, provided the challenges are not overwhelming (Elmquist *et al.,* 2003; Hempel 1996; Holling, 1996). On the other hand, consistent mismanagement can result in the transformation of pulse disturbances into chronic and compounded perturbations which can ultimately result in the dilapidation, alteration and in some case, removal of ecosystems (Bengtsson *et al.,* 2003; Paine *et al.,* 1998). In many developing countries[2] ineffective management of urban wastes[3] pose major threats to ecosystems and public health (*see for example,* Alam *et al.*, 1997; Amanullah, 1995; Asomani-Boateng, 2007; Bartone *et al.,* 1991; Berkun *et al.*, 2005; Boadi & Kuitenen, 2003; Damgbani *et al.*, 2008; Kasseva & Mbuligwe, 2000; Manga *et al.*, 2008; Mosha, 1990; Nemathaga *et al.*, 2007; Ogu, 2000; Onibokun, 1999; Post, 1999; Silitshena, 1996; 1992; Talyan *et al.*, 2008, Wang & Nie, 2001). Particularly perturbing are the risks posed by biomedical[4] pollutants due to their infectious and toxic composition. Under conditions of mismanagement, biomedical pollutants carry a greater risk of environmental contamination and human health infections more than any type of waste (Burke, 1994; Diaz, *et al.*, 2005; Klangsin & Harding, 1998; Pruss *et al.*, 1999;

[1] Ecosystems as used in this thesis refer to land, water and air resources and their living organisms.
[2] A developing country is where citizens generally have low income per capita, low rates of industrialization, low life expectancy and low standards of living. These include most of the countries in Africa, Asia, the Middle East, the Caribbean and Latin America.
[3] Waste can also be referred to as refuse, garbage, junk, rubbish or trash.
[4] Also known as healthcare, hospital, medical, immunization, clinical or infectious wastes

Socunya, Matias & Lapid, 1997; Tamplin *et al.,* 2005). In spite of the risks, the management of biomedical pollutants are not prioritized in many developing countries. The dumping of chemical, pharmaceutical, radioactive and human anatomical residue such as, body parts, limbs and organs in unsanitary waste dumps, drains and aquatic ecosystems have been reported in many areas (see for example, Ahmed, 1997; Alagoz & Kocasoy, 2008; Askarian *et al.,* 2004; Da Silva *et al.,* 2005; Gupta & Boojh, 2008; Hassan *et al.,* 2008; Mbongwe, Mmereki & Magashula, 2008; Mato & Kaseva, 1997; Nemathaga, Maringa & Chimuka, 2007).

The state of precariousness characterizing the management of urban wastes including biomedical pollutants in developing countries has been attributed to a multiplicity of factors chief amongst which is the phenomenon of rapid urbanization. Generally, many developing countries experience rapid urbanization due to the combined effects of high birth rates, reclassification of rural areas into urban centres and migration from rural areas (Cheema, 1987; Potter, 1994; Pugh, 2000; Visaria, 1997). Since the 1950s the populations of many cities in sub-Saharan Africa have increased more than sevenfold, while those in Asia and Latin America have quadrupled (WCED, 1987). In sub-Saharan Africa in particular, urban growth has historically been linked to the phenomenon of rural-urban migration. A major reason for this trend can be traced to the colonial[5] epoch where urban development was prioritized, leaving rural areas largely underdeveloped (Gugler, 1998; Hardoy & Satterthwaite, 1989). The continuation of urban biased development practices in the aftermath of colonization contributes to migration from rural areas to cities, resulting in exponential growth in urban populations in many developing countries. A report by the United Nations indicates that Africa's urban population grew at an annual rate of 3.4% in 2005-2010 while that of Asia increased by 2.8% during the same period (United Nations, 2011). Yet, sub-Saharan Africa represents one of the least urbanized regions in the world (Myers & Owusu, 2008; O'Connor, 1983).

[5] It is worth noting that all countries in Africa with the exception of Liberia and Ethiopia were at one point colonized by some European countries mainly, Britain and France and to a lesser extent, Portugal and Belgium.

Theoretically, high rates of urbanization can contribute to economic growth by broadening the tax base as well as increasing consumption, production and the provision of urban services (*see for example,* Lee-Smith & Stren, 1991; UNCHS, 1999). In practical terms however, urbanization in developing countries has been unaccompanied by economic growth, a situation Smith (1996) has described as '*exploding cities in unexploding economies'*. From 1965 to 1990 for instance, the Gross National Product (GNP) in Sub-Saharan Africa was 0.75% annually, while in juxtaposition, the urban population recorded a 3.3% growth rate (Malpezzi & Sa-Adu, 1996). Yet, it would be an act of gross misrepresentation to attribute the inability of authorities to effectively manage urban wastes in African countries solely on the challenges posed by urbanization and economic growth. In 2010, Africa´s average rate of growth amounted to 4.9%, up from 3.1% in 2009 and this is expected to accelerate to 5.8% in 2012 (AEO, 2011). The African Economic Outlook report for the year 2011 also indicates that financial flows to Africa have increased rapidly in the last decade. Between 2000-2010, Foreign Direct Investment (FDI), Portfolio Investment and Official Development Assistance (ODA) increased almost five-fold from USD 27 billion to USD 122 billion (AEO, 2011). The report goes on to state that "Africa's trade volumes with its emerging partners have doubled in nominal value over the decade and now amount to 37% of Africa´s total trade" (Ibid. 2011). The bright spots in Africa's economic outlook provide an indication that there are factors other than economics militating against the attainment of satisfactory outcomes in the management of urban wastes including biomedical pollutants. Perhaps chief in line with such deficiencies is the issue of good governance. As Hempel (1996) notes:

> "Effective environmental governance requires ecological "literacy," meaningful citizen participation, and allegiance to a common code of conduct that enhances the moral authority of political institutions, elevates debates about policy, and structures action plans for the common good of present and future generations" (p. 222).

Good governance thus requires interaction between power structures and civil society toward collective planning and decision-making (Swilling, 1997: p 5; Young, 1996).

Essentially therefore, good governance is rooted in the ideals of power sharing, flexibility, tolerance and respect for each other's views, especially that of local groups and communities (Nzomo, 1994; Owiti & Kibwana, 1994). In many developing countries however, environmental planning and decision-making processes tend to be top-down, technocratic and devoid of any meaningful citizen participation (see for example, Aina, 1997; Fekade, 2000; Fardon, 1995; Lee-Smith & Stren, 1991; Rondinelli, 1993). The lack of citizen participation is often justified on a view of local expertise as being fragmentary and provisional (Arce & Long, 1992). Yet, citizen participation is necessary for forging relationships, building networks and creating meaningful partnerships between the state and civil society. Local citizens may possess the social capital, knowledge, expertise and traditional values that can be harnessed to solve complex environmental problems. Despite such protestations, the top-down management approach reigns supreme in many developing countries. The reliance on the top-down approach often leads to massive policy failures and effectively erodes public confidence in the system. In countries where there are good policies in the books perverted implementation strategies impede the attainment of suitable outcomes in the waste management process. Added to the issue of ineffective governance are the challenges posed by corruption, political instability, resource constraints and technological limitations (Attahi, 1999; Onibokun & Kumuyi, 1999; Kironde, 1999; Swilling & Hutt, 1999). Ameliorating the management of urban wastes including biomedical pollutants in developing countries necessitates a paradigm shift. Such is the essence of this study.

1.2 Research Objectives

Using the Accra Metropolitan Area (AMA) in Ghana as a case study, this research explores ways in which the management of urban wastes including biomedical pollutants from healthcare activities might be ameliorated. The AMA was selected for the research due to the significant waste management challenges facing the metropolis. It has been reported that only 60% of the 1500-1800 tonnes of urban wastes generated in the AMA is collected and disposed in open dumps and unsanitary landfills (Government of Ghana, 2010). The vast majority of wastes that are left uncollected end up polluting terrestrial as well as marine and

freshwater ecosystems. To date, not much is known or understood about the management of biomedical pollutants in the Accra Metropolitan Area (AMA). The need to understand, and mitigate potential risks to the environment and human health accounts for the primary reason why the AMA was selected as a suitable case study location. Against this backdrop, the principal objectives of this research are to:

1. Investigate systemic and institutional arrangements pertaining to the management of urban wastes, including biomedical pollutants in the AMA.
2. Assess gaps, risks and constraints associated with current waste management practices in the AMA.
3. Develop a Framework for Urban Management of the Environment (FUME) that might provide a theoretical basis for understanding and addressing waste management challenges.
4. Explore the feasibility of applying the FUME model toward the amelioration of waste management practices in the AMA in line with the research findings

1.3 Research Questions

In line with the stated objectives of this research, the following questions are deemed pertinent:

- What is the state of urban waste management in the AMA?
- What is the status of biomedical pollutants in the urban waste management process in the AMA?
- Are there any gaps, risks and constraints associated with existing approaches to the management of urban wastes and biomedical pollutants in the AMA?
- How might the current approach to the management of urban wastes and biomedical pollutants be improved?
- Which salient features of existing environmental planning and management concepts can be integrated into the FUME model?

- How might the FUME be used toward improving the waste management situation in the AMA in line with the research findings?

1.4 Relevance, Significance and Importance of Study

This research is significant for many reasons. The FUME concept is intended to provide a refreshing way of thinking, understanding and addressing complex environmental problems characterized by high degrees of uncertainty in a developing country setting. In so doing, the FUME demonstrates the practicality of integrating complex systems thinking, local knowledge and innovation systems to addressing waste management challenges in a developing country setting.

The research is also important because it aims at providing an easy, inexpensive readily accessible and practical cynosure for planners, decision-makers and stakeholders who might have a need for it. This is particularly useful in a developing country context where important public documents are often restricted, unavailable and inaccessible to the general public. Stakeholders seeking practical solutions to the management of waste and biomedical pollutants may have access to this work via the internet. It is worth emphasizing that the recommendations provided in this thesis can be modified and applied toward addressing problems linked to the management of urban wastes and biomedical pollutants in other developing countries. The research is also significant because it represents one of the first of its kind to investigate systemic and institutional arrangements pertaining to the management biomedical pollutants in the AMA. In the past, researchers have focused exclusively on municipal wastes, while biomedical pollutants from healthcare activities have received scant attention. It is fervently hoped that the findings will provide a guide to policy-makers, healthcare providers, waste managers and all stakeholders when planning and making decisions about waste management and the environment.

1.5 Description of Study Area

The case study component of this research was undertaken in the Accra Metropolitan Area in the Greater Accra region of Ghana. An in-depth description of the country, region and location of the case study is provided next.

1.5.1 Country Description - Ghana

The Republic of Ghana (see figure 1.1) is a tropical country located in the Western part of the African continent bordered on the east by Togo, west by the Ivory Coast, north by Burkina Faso and on the south by the Gulf of Guinea. The country covers a total land area of 238,535 square kilometres or 92, 085 square miles and has a heterogeneous population of close to 24 million, representing over 100 ethnic groups.

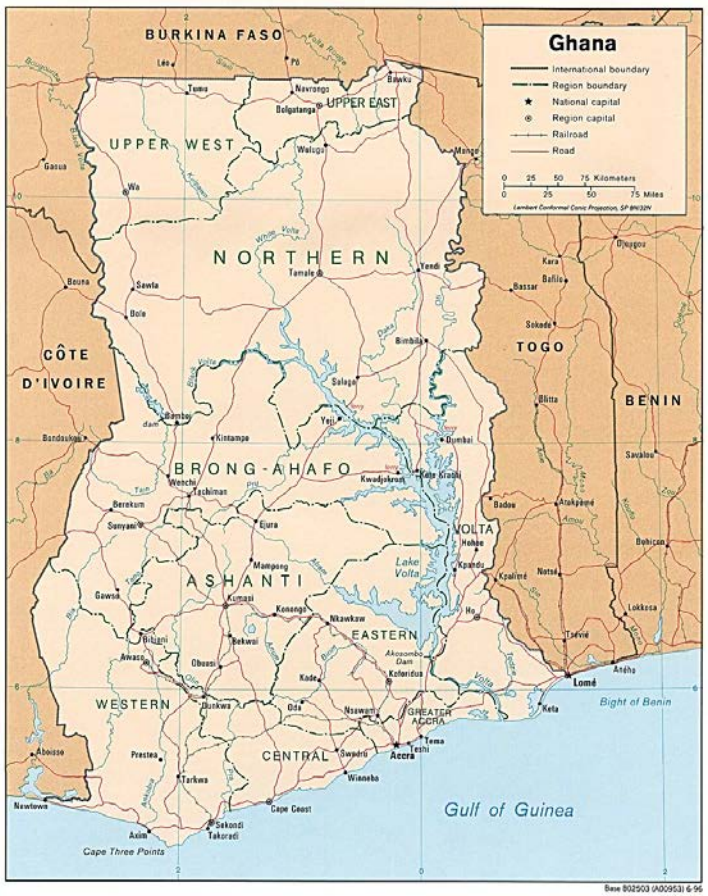

Figure 1.1: Map of the Republic of Ghana. Source: Ghanaweb, 2010

The Republic of Ghana is constituted of 10 administrative regions. These include: Ashanti, Brong-Ahafo, Central, Eastern, Greater Accra, Northern, Upper East, Upper West, Volta and Western regions. These regions are divided into 138 districts, each with its own District Assembly (DA). Christianity is the dominant religion (68.8%), followed by Islam (15.9%) and traditional religion (8.5%). Life expectancy rate is estimated at 59 years for males and 60 years for females, while infant mortality rate is pegged at 51 per every 1000 live births (Government of Ghana, 2008). Adult literacy rate is also pegged at 65% representing 71.7% for the male population and 58.3% for females. Urban population growth is estimated at nearly 4 percent per year while the growth rate for rural areas is fewer than 2 percent and expected to decline further (Adlakha, 1996). The economy of Ghana is largely agro-based accounting for 37.3% of the Gross Domestic Product (GDP) and employing 56% or 11.5 million of the total labour force. One of the world's leading exporters of cocoa, the country is also rich in a vast array of mineral and natural resources such as diamonds, gold, silver, manganese, timber and bauxite. Oil was discovered in commercial quantities as recently as 2007 and exploration activities begun in 2010. Ghana is currently one of the most stable liberal democracies in Africa following a tumultuous post-independence era of political instability. The first military coup in Ghana occurred in 1966 when the military and police overthrew the constitutionally elected government of the first republic. This trend continued until the early 1990s when the country embraced multi-party democracy which has since been sustained.

1.5.2 Description of the Greater Accra Region

The greater Accra region (see fig. 1.2) is one of the 10 administrative regions in Ghana. It is the most densely populated region in the country with a population of almost 3 million people inhabiting a total land area of 3245 square kilometres. Although it is the smallest of the 10 administrative regions, the Greater Accra Region is the second most populous in the country after the Ashanti region. Its total land size represents 14% of the total land area of Ghana. The population of the region increased from 491, 817 in 1960 when Ghana became a republic to 2,905, 726 as of the year 2000 (Government of Ghana, 2010).

Population density is estimated at 895.5 people per square kilometre. The region is divided into 5 major districts namely, the Accra Metropolitan Area, Tema Metropolitan Area, Ga East, Ga West, Dangme East and Dangme West districts. Mirroring the situation in the entire country, the population of the region is relatively diverse, comprising of different ethnic groups. Akan, Ga-Dangme and Ewe are the most dominant ethnicities in the region. As well, Christianity, Islam and traditional religion are the leading religious denominations in the region.

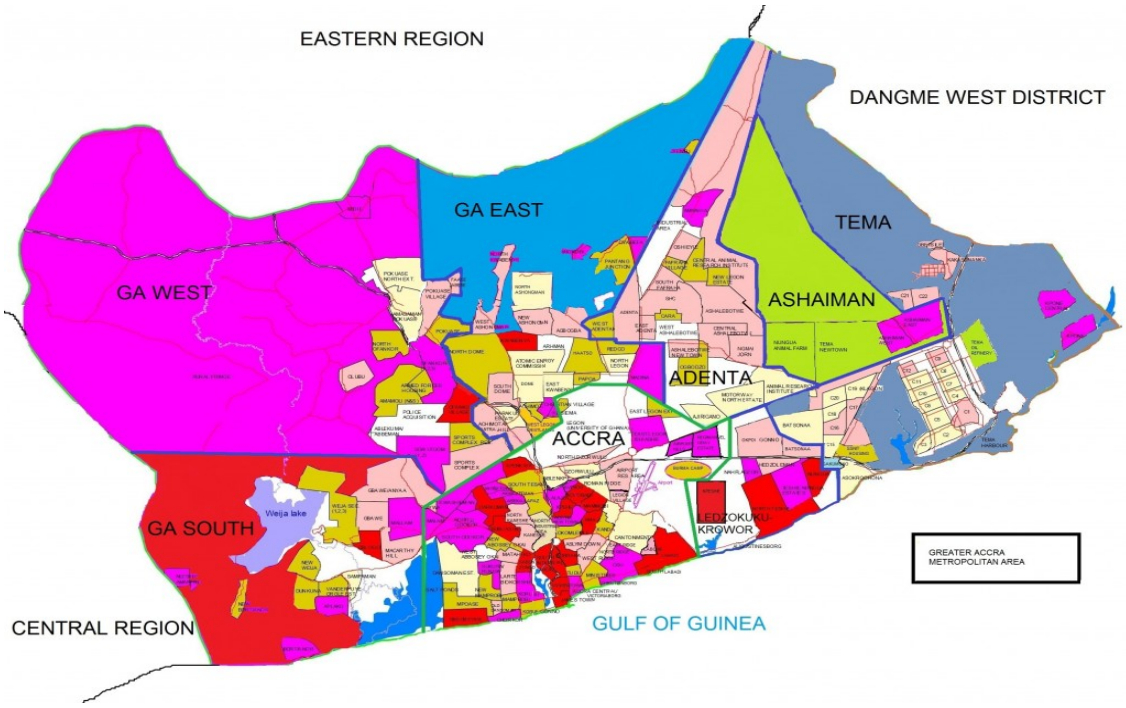

Figure 1.2: Map of the Greater Accra Region. Source: GhanatoGhana, 2010

1.5.3 Description of the Accra Metropolitan Area (AMA)

The Accra Metropolitan Area (see fig. 1.3) is the capital and largest city in Ghana and is originally the native homeland of the chiefs and people of the *Ga*[6] Traditional Area. The AMA lies in the savannah zone and has a tropical climate, with dry and rainy seasons each

[6] Ethnic group in Ghana who founded the AMA as far back as the 16th Century

year. The metropolis covers a total land area of 200 square kilometres and has a population of 2 million permanent residents with an annual growth rate of 3.4% (Grant & Yankson, 2003). This accounts for 25% of Ghana's total urban population (Ibid. 2003; World Bank, 2006). It has been estimated that another 2 million people commute to the metropolis on a regular basis for socio-economic activities. The AMA is stratified into 11 sub-metropolitan districts. These include: Ablekuma Central, Ablekuma North, Ablekuma South, Ashiedu Keteke, Ayawaso Central, Ayawaso East, Ayawaso West- Wuogon, La, Okaikoi North, Okaikoi South, and Osu Klottey. Neighbourhoods in these districts are hierarchically demarcated as first, second, third and fourth class residential areas respectively. As a primate city, the AMA serves as the nerve centre for socio-economic and political activities in Ghana and has a heterogeneous population.

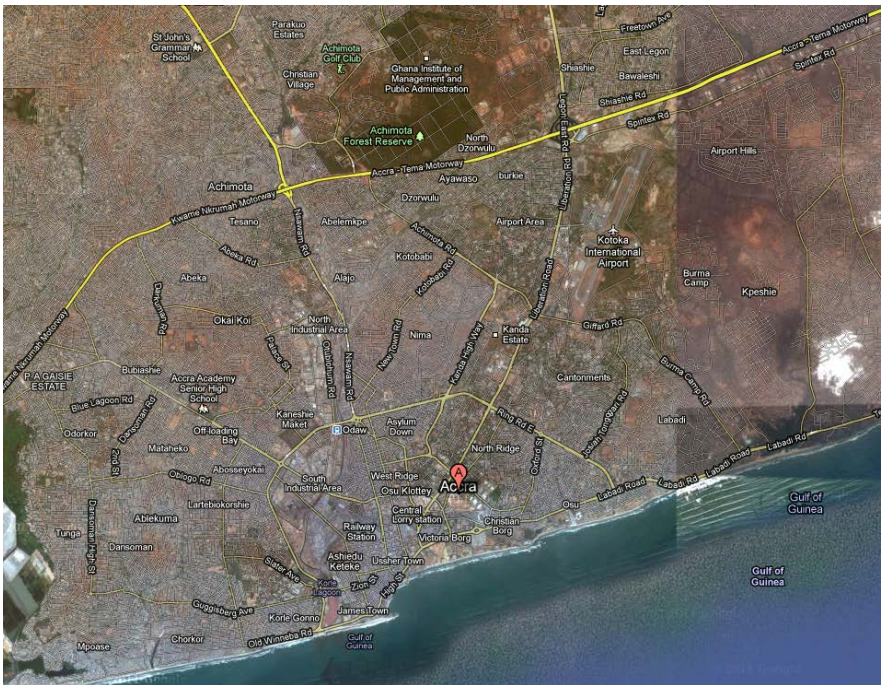

Figure 1.3: Aerial Map of the Accra Metropolitan Area. Source: Google Maps, 2011

1.6 Organization of the Thesis

This work is organized into eight main chapters. The current chapter presented an introduction to the overall research program including the goals, objectives and relevance of

the study. Chapter 2 dissects the ethos of waste management from a theoretical and historical perspective. The chapter highlights some of the major approaches to waste management including landfilling, incineration, recycling, minimization and composting. Waste management concepts such as: Life Cycle Analysis, (LCA) Waste to Energy (WTE) Extended Producer Responsibility (EPR) and Integrated Waste Management (IWM) are also discussed thoroughly. In chapter 3, an extensive analysis of biomedical pollutants generated in the course of healthcare activities is presented. An in-depth discussion of some of the major environmental and human health risks associated with biomedical pollutants is also discussed in the chapter. Chapter 4 is dedicated exclusively to the management of urban wastes, including biomedical pollutants in developing countries. The discussion in this chapter highlights the failure of the conventional approach to waste management planning and decision-making and its technocratic and top-down features. In chapter 5, an extensive review of environmental planning and management theories is presented with a view of selecting salient building blocks for the Framework for Urban Management of the Environment (FUME). Theories and concepts highlighted in the discussion include: the precautionary principle, ecosystem approach, adaptive management, risk management, co-management and planning theory. Chapter 6 presents the research epistemology, methodology and design. Here, post-positivism and mixed-methods approach to data collection is accentuated. The case study findings are presented and discussed in chapter 7. The final chapter (8) examines the feasibility of applying the FUME to waste management in a developing country setting, using the AMA as a case example. A synthesis of the thesis concludes the chapter. An outline of main chapters of the thesis is presented in table 1.1 below.

Table 1.1: Outline of Main Chapters of the Thesis

Chapter 2

Waste Management: Tools, Concepts and Approaches

2.1 Introduction

The proclivity to generate waste is an inevitable consequence of most human activities. Each year, billions of metric tonnes of waste are produced by households, industries, institutions and commercial establishments all over the world that require safe and effective management. Whose responsibility is it? How has waste been managed in the past? What are the major approaches to waste management service delivery and who is involved? What are the advantages and drawbacks of the various techniques for managing waste? The central objective of this chapter is to critically analyze the ethos of waste management from theoretical, historical and contemporary perspectives. Section 2.1 introduces the general theme of the chapter. In section 2.2, a definition of waste is provided. This is followed by a brief discussion of the hazardous and non-hazardous classifications of waste in 2.3. A historical overview of waste management is the focus of attention in section 2.4. A theoretical analysis of approaches to waste management service delivery is presented in 2.5. Section 2.6 examines the major techniques and concepts in the waste management discourse. Section 2.7 concludes the chapter. The analyses provided in this section are intended to serve as a precursor to the review of the literature on waste management in developing countries. The fundamental objective of this chapter is to provide the reader with an understanding of some of the critical tools, concepts and approaches often used in the waste management discourse.

2.2 Defining *Waste*

There exists no universally accepted definition for what constitutes waste. However, most common definitions embrace the notion of a residual object, substance or material considered ‘useless’ by its owner and is therefore discarded (Bilitewski, 1994; Dhamija, 2006; Furedy, 1997). This definition underscores the idea that some wastes can be recovered

or retained for future use through the processes of reusing, recycling or composting (Tchobanoglous, Kreith & Williams, 2002). Effectively, materials that have no possible future use can be considered as absolute waste. Waste can be solid, liquid and gaseous in composition. Solid waste refers to the types of residual substances that have no kinetic mobility and are therefore likely to accumulate on the site where they are produced such as metals, glass, textiles and wood residues (Enger & Smith, 2004). This excludes atmospheric emissions and wastewater discharge (Dhamija, 2006). Liquid wastes on the other hand, are aqueous in nature and typically possess kinetic mobility such as, discarded paints, solvents and unwanted wastewater discharged into drains and sewers. Gaseous wastes entail discarded or unwanted flammable gases such as methane.

2.3 Non-Hazardous vs. Hazardous Wastes

Generally, wastes tend to be hazardous or non-hazardous, depending on its origins and composition. Non-hazardous wastes refer to discarded solid and liquid residue that possesses no physical, chemical and biological substances in significant concentrations to pose a threat to the environment and human health. In other words, non-hazardous refer to the types of wastes generated in households as well as the Industrial, Commercial and Institutional (IC&I) sectors of society that do not require specialized management provisions. Examples of non-hazardous wastes include discarded paper, glass, metals as well as regular yard and kitchen residue. Non-hazardous wastes are common and are generated on a regular basis in many societies around the world. It is estimated that Canadians generate over 30 million tonnes of non-hazardous waste each year, representing more than a ton of garbage for every man, woman and child (Government of Canada, 1992).

Hazardous wastes on the other hand, refer to discarded residues from households as well as the IC&I sectors that typically possess physical, chemical and biological characteristics in significant quantities to potentially have a deleterious effect on human health and the environment (Dawson & Mercer, 1986; Goldman *et al.*, 1986). Such wastes tend to be infectious, corrosive, poisonous, flammable and/or explosive and therefore require special management provisions (Dawson and Mercer, 1986; Wagner, 1999). Examples of

hazardous wastes generated in households include discarded cleaning materials, paints, solvents, expired medication and used batteries. Within the IC&I sectors, hazardous wastes tend to be anatomical, infectious, chemical, pharmaceutical, radioactive in composition. Biomedical pollutants generated in the course of human and animal healthcare activities represent one of the most common types of hazardous wastes and is discussed extensively in the next chapter. Figure 2.1 below depicts the amount of hazardous waste generated in different world regions in 2009. The figure that hazardous waste generation in developed countries tends to be relatively higher in comparison to developing countries suggesting a direct correlation between industrialization and the generation of hazardous wastes.

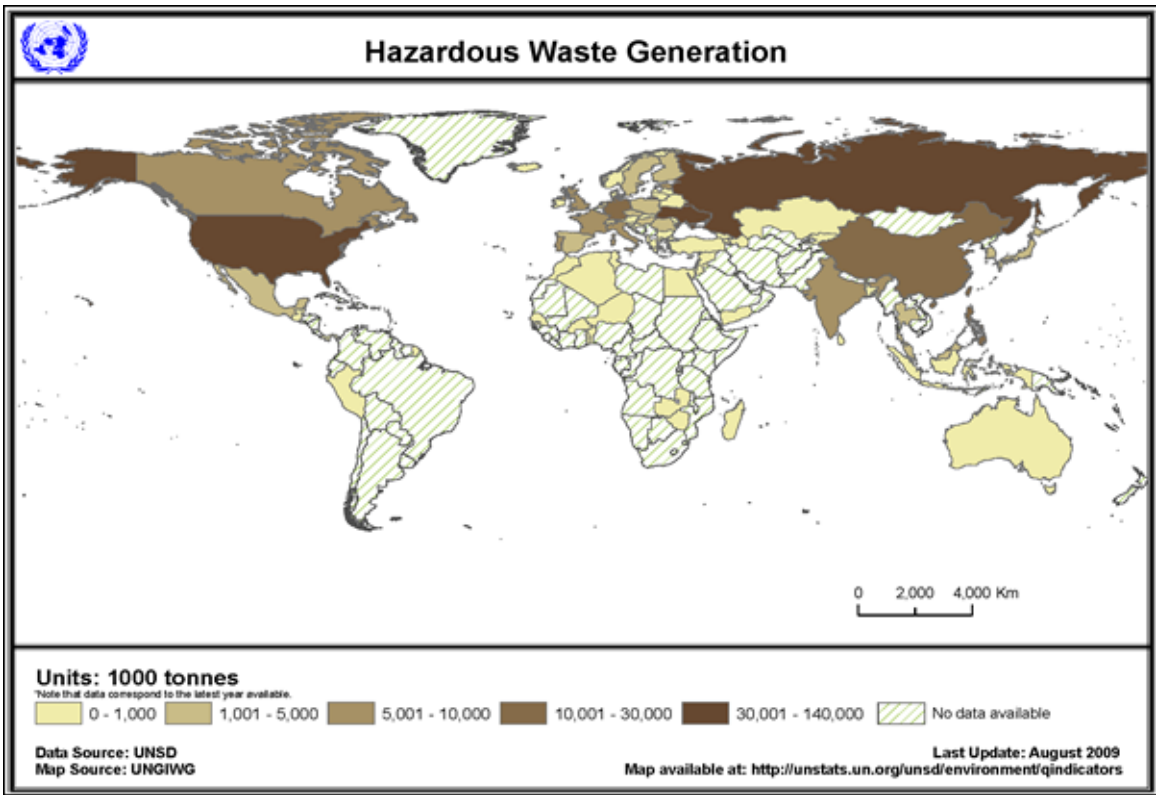

Figure 2.1: Hazardous waste generation by world region. Source: United Nations Statistics, 2010

2.4 Defining Waste Management

Waste management can be defined as the organized collection, transportation, processing, recycling or disposal of wastes in ways that minimizes potential ruinous effects on the environment and human health (Cointreau-Levine, 1994; Tchobanoglous, 2009). Available evidence in the literature indicates that waste management is not a nascent concept although, the process have undergone significant transformations over the years. For centuries, many societies practiced waste management through regulations, collection and disposal practices (Bilitewski, 1996; Melosi, 2005). The Indus River city of Mohenjo-Daro (now modern day Pakistan) constructed homes with built-in garbage chutes and trash bins dating back to 2500 BC (Melosi, 2005). Some ancient Middle Eastern societies constructed houses with vertical pipes in the kitchen which led directly to a waste collection facility located directly under the kitchen dating back 6500 years (Lemann, 2008). Many ancient cities in Europe and Asia are also reported to have practiced organized waste management by designating spaces for disposal (Bilitewski, 1996). Similar conditions have been reported in ancient China where some cities employed the services of a sanitary police task force for street sweeping in the second century BC (Melosi, 2005). In ancient Jerusalem, authorities composted organic wastes and disposed of inorganic residue in a dump near the cemetery in the valley of Kidron (Lemann, 2008). A sanitary code of laws written by Moses in 1600 BC required Jews to remove and bury their wastes far from their living quarters (Melosi, 2005).

While some ancient cities practiced organized waste management, others faced unprecedented challenges. In Rome for example, waste collection was restricted to state-sponsored events such as parades and gladiatorial games while the rest of the city drenched in garbage (Melosi, 2005). Similarly, waste collection in the ancient Egyptian city of Heracleopolis[7] was restricted to elite quarters while the non-elite parts of the city were ignored (Ibid. 2005). Historically, residents of Edinburgh, Scotland disposed of their waste in the evening hoping for scavengers to collect such wastes by the morning (Ibid. 2005). In

[7] Founded before 3000 BC,

most instances, ancient cities people simply discard waste including human excrement in the streets (Lemann, 2008). Open dumping remained the dominant disposal option while scavengers collected and sold waste including excrement as fertilizer (Melosi, 2005).

The advent of the industrial revolution in the 20th Century aggravated the waste management situation due to its contribution to urban sprawl and consumerism (Nag, 2005; Sasikumar & Krishna, 2009). However, the industrial revolution also ushered in an era of policy initiatives and technological advancements which would prove useful toward the amelioration of urban waste management practices (Sasikumar & Krishna, 2009). During this period, indiscriminate littering gave way to organized collection; open dumping was substituted with sanitary land-filling and; crude burning was replaced by incineration technology. In spite of such advancements, waste management continues to pose a problem for the environment and human health.

2.5 Waste Management as Public Health and Environmental Issues

Historically, risks to public health had provided a catalyst for scientific interest in waste management (see *for example,* Bilitewski *et al.,* 1996; Blumberg & Gottlieb, 1989; Hempel, 1996; Melosi, 2005). In North American cities, ineffective waste management practices contributed to the outbreak of diseases that resulted in many fatalities (Melosi, 2005). Similar conditions had been reported in many European cities. In 19TH Century Prussia for example, there was an outbreak of nine cholera epidemics during 1831 to 1873 which contributed to 380,000 fatalities (Bilitewski *et al.,* 1996). A similar outbreak of cholera in Hamburg, Germany afflicted 9000 people in a relatively short period, costing the city 420 million Gold Marks in 1892 (Ibid. 1996). The underlying causes of such outbreaks were linked to unsanitary environmental conditions caused by ineffective waste management practices. While threats to public health had historically sparked scientific interest in waste management research, environmental protection has only evolved as major factor in the last few decades.

2.6 Approaches to Waste Management Service Delivery – A Theoretical Analysis

Waste management service delivery typically assumes three main theoretical approaches: the conventional, non-conventional and integrated waste management approaches (Ali & Saywell, 1995; Arlosoroff, 1991; Armstrong, 1993; Cointreau, 1982). In this section, these various theoretical approaches are examined.

2.6.1 The Conventional Approach

The conventional approach typically involves the collection and disposal of waste with little or no emphasis on minimization, recovery and recycling (Cointreau, 1982). Within the conventional approach, waste management functions are carried out by local governments or municipalities (Cointreau, 1982; Gidman *et al.*, 1995; Oluwande, 1984; UNCHS, 1988). Funding is mainly allocated by central governments while additional revenue is mobilized through user charges, municipal taxes and external donor agencies (Ali *et al.*, 1999; Bubba & Lamba, 1991; Gilbert *et al.*, 1996; Van de Klunkert & Lardinois, 1994). Proponents often cite operational efficiency as a fundamental hallmark of the conventional approach (Furedy, 1984). Conversely, critics charge that the concentration of power in the hands of bureaucrats and politicians makes the conventional approach susceptible to corruption and mismanagement (Chapman, 1979; Hatry, 1983; Niskanen, 1971). In addition, the conventional approach has proven to be an expensive concept that absorbs 30-50% of municipal budgets in developing countries (Arlosoroff & Bartone, 1987; Sicular, 1992). Moreover, the reliance on central governments and external agencies for funding within the conventional approach makes the process prone to political interference and influence peddling (*see for example,* Ali *et al.*, 1999; Bubba & Lamba, 1991; Leduka, 1991; Musandu-Nyamayaro, 1991; Mwafongo, 1991). Perhaps pertinent to the excesses of the conventional approach is its centralized disposition, which allows for little or no participation of relevant stakeholders in the planning and decision making process (Sinha, 1993; Soerjani, 1984). Furthermore, the 'collect and dispose' approach embedded in the

conventional approach is an unsustainable concept that exerts significant amounts of pressure on the environment.

2.6.2 The Non-Conventional Approach

The non-conventional approach is predicated on a view of waste as a resource that can be harvested and reused or recycled (Furedy, 1994). This approach evolved within the informal sector in developing countries where wastes are typically recovered through scavenging (Adeyemi, Olurunfemi & Adewoye, 2001; Beukering *et al.*, 1999; Korfmacher, 1997; Medina, 1997). Historically, it has been estimated that 2% of the population in developing countries are dependent on the recovery of waste for survival, collecting 5-15% of the total volume of waste (Bartone, 1988; Romanos & Chifos, 1996). In the past, it had been reported that 2% of the total volume of waste generated by residents in the Kenyan capital city of Nairobi had been collected by scavengers (Syagga, 1992). In Mexico, 10% of total volumes of waste are recovered by scavengers (Beede & Bloom, 1995). Cointreau (1982) has also noted that 40% of wastes generated in Lahore, Pakistan had historically been collected by livestock farmers. Scavenging activities usually occur at collection depots, transfer points, streets and dumpsites sites (Amanullah, 1995; Cointreau, 1984; Chaplin, 1995; Furedy, 1984).

The emphasis on recovery within the non-conventional approach marks one of its major strengths due to its potential to divert wastes from landfills and incinerators. Scavenging also provides employment activities for people within the informal sector in developing countries. On the other hand, the non-conventional approach has failed to improve waste management practices in any meaningful way and many developing countries continue to face major challenges. The recovery of wastes as resources also arouses major concerns around public health due to the risk of contamination and infection for waste pickers and the general public.

2.6.3 The Integrated Waste Management (IWM) Approach

The Integrated Waste Management (IWM) approach involves a process of applying a variety of waste management techniques to waste management service delivery. The IWM approach considers the environmental, energy, socio-economic and political impacts of waste management techniques and seeks to incorporate options with the potential to cause less harm (Tchobanoglous *et al.,* 1993). Citizen participation in the planning and decision making process is a cardinal feature of the IWM approach. The emphasis on public participation poses major hurdles for many developing countries due to the reliance on the conventional approach. Additionally, the IWM approach imposes demand for substantial financial, technical and human resources which are lacking in many developing countries (Ali, Coad & Cotton, 1996; Fernandez, 1993; Furedy, 1993). Furthermore, the IWM approach requires effective coordination and partnership among various agencies which is a huge problem in developing countries.

2.7 Waste Management - Techniques and Concepts

This section is intended to provide critical insights into the major approaches to waste management. These include the concepts of waste minimization, recycling, composting, incineration and landfilling. Other concepts such as, Extended Producer Responsibility (EPR), Life Cycle Analysis (LCA), and Waste to Energy (WTE) are also analyzed. The analysis in this section is deemed relevant for providing a basis for understanding some of the key terminologies used extensively in this thesis.

2.7.1 Waste Minimization

Waste minimization[8] involves any technique, process or activity carried out for the purpose of avoiding, eliminating or reducing the amount of residues generated (Crittenden & Kolacskowzi, 1995; Zhu *et al.*, 2008). At the household level, waste minimization efforts typically involve reducing and reusing of products. Waste minimization initiatives within the

[8] Also referred to as pollution prevention or source reduction

IC&I sectors entails the conscious design, manufacture, packaging, purchasing and using of products with less disposable residue (Chandra *et al.*, 2006; Lee *et al.*, 2002; Pruss *et al.*, 1999). Thus, as a waste management technique, minimization offers the benefit of diverting wastes from landfills and incinerators thereby reducing the burden on the environment and also, saving businesses and institutions disposal costs (Crittenden & Kolaczkowski, 1995). Additionally, waste minimization can assist the IC&I sectors with reducing liabilities and costs through the use of less energy as well as durable materials during production (Dennison, 1995). This has the potential to contribute to an increase in profit margins both in the long and short terms while saving the environment.

Conversely, waste minimization efforts may be impeded by a myriad of economic, cultural and technical issues (see table 2.1). These include high costs of procuring specialized raw materials and equipment, employee training, and appropriate technologies (Crittenden & Kolaczkowski, 1995; Sasikumar & Krishna, 2009). Such challenges can contribute to increasing production costs which might be transferred to the consumer (Crittenden & Kolaczkowski, 1995). Consequently, senior management may feel reluctant to implement minimization strategies especially in instances where the competition is stiff. Coupled with this are concerns around product quality and customer acceptance (Ibid. 1995). Packaging has been an effective marketing tool that has been used to attract consumers (Enger & Smith, 2004). The use of less packaging might alter the quality of the product and customers may be unwilling to buy. This can negatively impact the profit motive that drives many businesses.

Table 2.1: Economic, cultural and technical obstacles to waste minimization within the IC&I sectors

Economic	Cultural	Technical
Overall production cost increases ▪ Raw material cost increases ▪ Production rate decreases ▪ New equipment is required	Lack of commitment from senior management Inflexible organizational Structure Bureaucracy	Lack of suitable engineering information and techniques Concerns about change to product quality and customer acceptance
Greater capital investment is	Lack of awareness of	New operation may not work as

needed than for pollution control and waste treatment is required	corporate goals and objectives	expected or may create bottlenecks in production Production facility may not have space to easily accommodate additional equipments.
Cost increases or projects may not be profitable even when less tangible benefits are included	Individual or organizational resistance to change	Retrofitting of process may cause shut down of existing operations
Waste minimization projects may seem tangible but may be impeded by the lack of capital	Poor internal Communication Restrictive employment practices	Negative employee reaction such as: ▪ It has been tried before ▪ It cannot be done

Adapted from Crittenden & Kolaczkowski, 1995

2.7.2 Recycling

Recycling involves the conversion of rejectamenta into new useful products through physical, chemical or biological processes (Cunningham & Cunningham 2004; Enger & Smith, 2004; Oskamp, 1995). Usually, recyclables are collected through buy-back, drop-off and/or curb-side programs and sent to recycling plants for conversion. As a waste management option, recycling has several benefits including the transformation of waste into a resource that can be retained or harvested as a raw material (Cunningham & Cunningham 2004; Oskamp, 1995). This has the potential to contribute to resource conservation, while diverting wastes from landfills and incinerators (Maclaren & Yu, 1998). Recycling can also create jobs and boost economic development in local communities. Notwithstanding these potential benefits, recycling as a waste management technique can face several challenges. In some cases, the value of recycled products are sometimes not enough to cover the costs of collecting, storing, transporting, processing and packaging (Cunningham & Cunningham 2004). There also tends to be a misconception among consumers that recycling products are inferior. This can significantly induce reluctance to buy on the part of consumers. Furthermore, limitations in technological innovations can be an impediment to recycling (Enger & Smith 2004).

2.7.3 Composting

Composting is commonly defined as the controlled biological decomposition of organic material with the aid of air, moisture, temperature, fungi and bacteria (Epstein, 1997; Haug, 1993). The end product of composting is compost which is defined as a stabilized organic soil conditioner devoid of human and plant pathogens which is beneficial to plant growth (Haug, 1993). Compost is used primarily as a soil amendment or mulch by farmers, horticulturalists and households as nutrients that enable plant growth. The process of composting can take place either in closed reactors or in outdoor windrows[9]. Closed reactor composting systems offer greater means of controlling the process in comparison to open systems although it has higher initial and operational costs (O'Leary, 1995). The windrow systems are more versatile and produce more highly predictable results (*see for example*, Epstein, 1977; O'Leary, 1995).

Composting can be undertaken through aerobic and anaerobic processes. Aerobic digestion is defined as the bacterial process of decomposition or rotting occurring in the presence of oxygen (Haug, 1993). Under aerobic conditions, bacteria are used to rapidly consume organic matter and convert it into carbon dioxide. This requires by high temperatures which allow rapid decomposition. Anaerobic digestion (AD) on the other hand, is a process by which organic materials in an enclosed vessel are broken down by micro-organisms, in the absence of oxygen. This process is typified by a slower rate of decomposition due to low operating temperatures as well as the discharge of a mephitis odour.

Composting as a waste management technique has several benefits. It assists societies to divert waste from landfills and incinerators by transforming waste into a resource that can be used to improve the aesthetics of an area. Compost also enhances the appearance and texture of soil, increase soil fertility, increases the ability of the soil to retain water, moderate temperature and also suppress the growth of weed and plant diseases (Haug, 1993). In

[9] Other types include static pile and, vermicomposting

addition to its uses as a soil maintenance agent, compost can also be used as an earth-covering application (Haug, 1993).

Despite its viability as a waste management option, there are a number of challenges associated with composting. Large scale composting technologies are expensive and can be labour intensive. There is also a danger of leachate pollution especially in areas where large scale composting is carried out. The release of ammonia gas during composting can contribute to devaluing the quality of compost and may also cause a myriad of environmental problems (O'Leary, 1995). In addition, hazards such as heavy metal contamination, organic chemical compounds from pesticides and herbicides, disease vectors pathogenic infections are pressing concerns associated with composting. Furthermore, noise pollution from trucks hauling organic wastes to composting sites, dust and other inconveniences poses an affront to composting as a viable waste management option. Another challenge lies in the area of finding markets for compost. In spite of its drawbacks, composting is one of the preferred waste management options and is practiced in many countries including France, Germany and Spain. Currently, there are over 100 composting facilities in Germany with 17 under construction (Agunwamba, 1998).

2.7.4 Incineration

Incineration involves a regulated thermal destruction process that converts combustible materials into non-combustible residue or ash (Brunner, 1991; CCME, 1992; Enger & Smith, 2004). The are many types of incineration systems including grate burners, fluidized bed burners and more recently, pyrolysis and gasification (Porter, 2002). As a waste management option incineration has several benefits. It can reduce the volume and toxicity of solid, liquid and gaseous[10] residue by as much as 80-90% (Enger & Smith, 2004; Hill, 2004, Levendis *et al.*, 2001). Incineration technology is also capable of generating energy for heating purposes. Further, incineration facilities impose a lesser demand for land in comparison to land-filling.

[10] This depends on the type of technology and design.

Conversely, incineration has been critiqued as a costly and expensive technique due to its demand for high capital, technical and human resources (Brunner, 1991; Rand, Haukohl & Marxen, 2000). This can be a major problem for cash-strapped municipalities especially in developing countries. In addition, incineration may also contribute to the retardation of recycling efforts (Petts, 1994). The disposal of incinerated ash in landfills may also cause pollution of surface, ground and drinking water (Enger & Smith, 2004). Further, incineration contributes to the discharge of dangerous dioxins and furans into the atmosphere causing significant levels of air pollution. Dangerous particles include poly-nuclear aromatic hydrocarbons (PAH), polychlorinated dibenzo-furans (PCDF), polychlorinated dibenzo-para-dioxins (PCDD) polychlorinated biphenyls (PCBs), hydrogen, lead, mercury, cadmium, chlorobenzenes, particulate matter and chlorophenols (Bakoglu e*t al.,* 2004; Levendis *et al.,* 2001). The discharge of such dangerous toxins into the environment becomes more pronounced especially when the type of technology used is obsolete and archaic.

There exist ample empirical evidence (see tables 2.2 & 2.3) which suggest a direct correlation between air pollutants and adverse effect on the health of humans (Cordier *et al.*, 2004; Enger & Smith, 2004; Ryder 1997) and livestock (Lloyd *et al.,* 1998). A study undertaken in France by Cordier *et al.* (2004) revealed a direct nexus between dioxin released from incinerators and birth defects. Ryder (1997) also conducted a study on the effects of incinerators on human health and concluded that people living within one kilometer of municipal solid waste incinerators suffered significant increases in all cancers, including a 37 percent increase in liver cancers. Similarly, Mao *et al.* (2007) undertook a study on the mass distribution of airborne particle near a medical waste incinerator in Taiwan and found that despite the availability of air pollution control system, emissions from the incinerator caused significant levels of air pollution jeopardizing human health. In Turkey, Bakoglu *et al.* (2004) found concentration of organic chemicals in the ambient to be higher than acceptable occupational health limits. However, using modern incineration technologies has been shown to curtail some of these risks although concerns regaring financial costs remain (Wrbitsky *et al.,* 1995).

Table 2.2: Air pollutants linked with incineration

Major classes	Subclasses	Typical Members of the Subclasses
Inorganic Gases	Oxides of nitrogen Oxides of Sulfur Oxides of Carbon Other Inorganics	Nitric Oxide, Nitrogen Dioxide Sulfur Dioxide, Sulfur Trioxide Carbon Monoxide, Carbon Dioxide Hydrogen sulfide, Hydrogen Fluoride, Ammonia, Chlorine
Organic Gases	Hydrocarbons Aldehydes and Ketones Other Organics	Methane, Butane, Octane, Benzene, Acetylene, Ethylene, Butadiene Formaldehyde, Acetone Chlorinated Hydrocarbons, Organic Acids, Benzo-(a)-pyrene, Alcohols
Particulates	Solid Particulate Liquid	Fume, Dust, Smoke, Ash Carbon, Lead Mist, Spray Oil, Grease, Acids

Adapted from Brunner, 1985

Table 2.3: Air pollutants linked with adverse human health risks

Pollutant	Effect
Ozone	Induces coughing, chest discomfort, irritation of the nose, throat and trachea, aggravates asthma, emphysema, chronic bronchitis. Causes breakdown of chromosomes in laboratory animals and hemolytic anemia in humans Acts on the human immunology system to reduce its resistance to bacterial infections Acts on the neurological system to reduce ability to concentrate
Sulfur Dioxide	At high ambient levels it causes chemical bronchitis May accentuate viral pneumonia Can produce emphysema and Pulmonary Fibrosis
Carbon Monoxide	Produces reversible neurological effects such as headaches and dizziness Can lead to chronic oxygen deficiency
Nitrogen Dioxide	Reduces the ability of the lungs to cleanse itself of particulate matter Can destroy cilia and suppress alveolar macrophage activity
Hydrocarbons	Can induce eye irritation Can cause cancer

Adapted from Brunner, 1985

2.7.5 Landfilling

Landfilling involves the controlled deposit of waste in a designated space and covering such wastes with top-cover (see figure 2.2) as a means of minimizing and preventing pollution (Bagchi, 1990:168; Koerner & Daniel, 1997). Top-covers are applied for health and aesthetic reasons as it captures and prevents the release of gaseous pollutants into the atmosphere (Koerner and Daniel, 1997). Top-covers also minimize occurrences of water infiltrating into the waste deposit (Bagchi, 1990). Wastes deposited in landfills undergo a process of decomposition with the aid of oxygen, temperature and water (Lu *et al.*, 1985). Ultimately, organic components are broken down with the aid of micro-organisms in the soil and ferrous metals ultimately decompose by oxidization (Ibid. 1985).

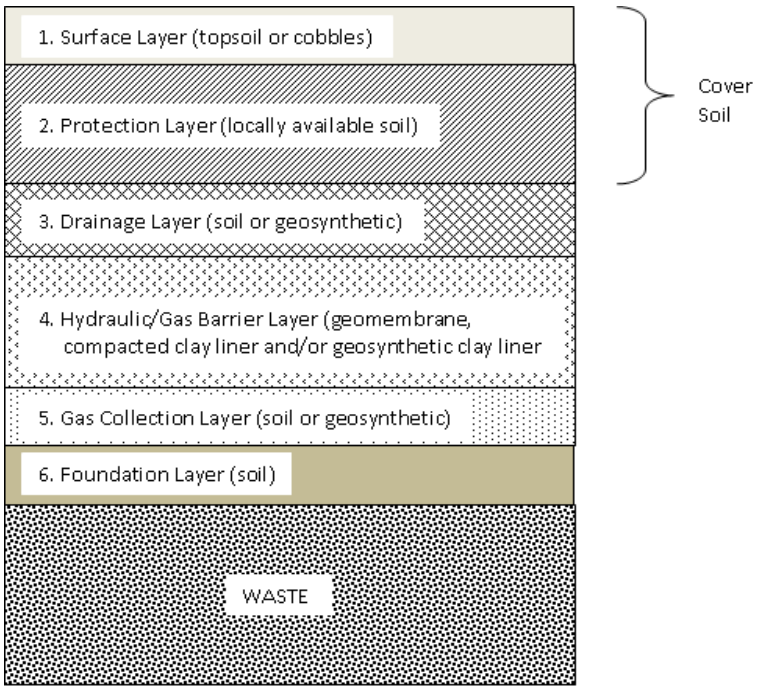

Figure 2.2: Stages of landfill layering

Adapted from Koerner & Daniel, 1993

As a waste management option, landfilling has several advantages. It is simple, versatile and relatively inexpensive to operate and maintain in comparison to other options such as incineration (Chermisinoff, 2003). It offers a final disposal route for waste generated

from end of pipe-of-treatment processes such as incineration as well as other waste management options (Chermisinoff, 2003). Most sanitary and properly engineered landfills are equipped with gas extraction systems which serve the purpose of recovering and controlling the migration of gases (Bacopoulos, 1991; Chermisinoff, 2003). Through this process, landfill gases can be harvested and utilized for heating and energy purposes as a low polluting fuel. Furthermore, old landfills can be used for leisure and recreational purposes thereby contributing to the creation of local jobs.

On the other hand, the process of land-filling carries several risks to the environment and human health. Landfills produce leachates[11] which contains pollutants such as, dissolved organic matter, inorganic macro components, heavy metals and xenobiotic organic compounds (Bagchi, 1990; Koerner & Daniel, 1997). These substances are known to have subtle and long term effects on ecosystems and human health (*see for example,* Aluko & Sridhar, 2004; Read *et al,* 1998; Walsh & Lafleur, 1995). Moreover, landfills generate toxic gases that can contribute to global warming including methane[12], carbon dioxide (CO_2), Hydrogen Sulphide (H_2S) and Volatile Organic Compounds (VOC), Oxygen, Nitrogen, Benzene and vinyl chloride (Bagchi, 1990). Landfills also produce hydrogen sulphide (H_2S) which when inhaled at high concentrations can cause headaches, dizziness, nausea and certain types of cancer (Goldberg *et al.,* 1995). Furthermore, the construction of landfills requires large tracts of land and may attract disease causing vermin, alter the aesthetics of the physical environment and require high post-closure maintenance costs. Other concerns of land-filling include post-closure maintenance costs, aesthesis and the possibility of attracting disease causing vermin (Koerner & Daniel, 1997; Noble, 1976).

2.8 The Waste Management Hierarchy

The waste management hierarchy (figure 2.2) outlines a classification framework for waste management options in terms of their potential to minimize ruinous effects on the

[11] Liquid waste water residue that is generated in landfills and open dumps
[12] A colourless and odourless gas which can be explosive at high concentrations

environment (Hill, 2010; Sasikumar & Krishna, 2009; Zhu *et al.*, 2008). Its main tenets are based in the assumption that the diversion of wastes from landfills and incinerators is congruent with the ideals of environmental sustainability. Subsequently, the hierarchy accentuates the concepts of reduce, reuse, recycle as most desirable options while incineration and land-filling are considered less favourable (White, Franke & Hindle, 1995).

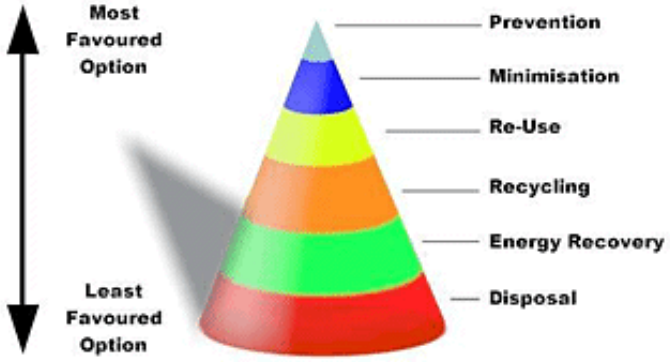

Figure 2.3: The waste management hierarchy

Source: Greenstar, 2010

Theoretically, the emphasis on minimization, reusing and recycling as desirable options in the waste management hierarchy is congruent with the ideals of sustainable development. Such practices ensure the diversion of wastes from landfills and incinerators. In practical terms however, the hierarchy does not address socio-economic, technical, and political barriers to effective implementation of its preferred options. The waste management hierarchy also fails to highlight treatment of hazardous wastes as an option. A major weakness of the waste management hierarchy therefore lies in its view of waste as homogenous, rather than consisting of several unique characteristics. Such an oblique view may militate against the attainment of effective waste management outcomes. For example, the preferred options outlined in the hierarchy may not necessarily work favourably in the context of managing infectious and hazardous biomedical residue. Thus, the waste management hierarchy although a useful concept, is laden with some major weaknesses.

2.9 Extended Producer Responsibility

Extended Producer Responsibility[13] **(**EPR) is a strategy designed to decrease environmental impacts of products by making the manufacturer responsible for take-back, recycling and final disposal (OECD, 2001). Essentially, EPR can be considered a policy tool that requires producers to be financially and physically responsible for their products at the end of its useful life (Levy, 2000).The concept is believed to have originated in Germany and Sweden in the 1990s and has since gained traction in other parts of Europe, Asia and North America (Asolekar & Gopichandran, 2005; Levy, 2000). EPR has four underlying objectives: 1) to achieve high levels of reuse, recycling and other forms of recovery; 2) to change behaviour, especially to influence material use and product design decisions by manufacturers; 3) to highlight talents of producers for activities that recount their qualities as designers, marketers and distributors and; 4) to earn financial resources to allow environmental and waste management goals to be consummated, rather than trying to accomplish them through public or taxed -based sources (Asolekar & Gopichandran, 2005: p. 425).

As a waste management strategy, EPR has several benefits. The process contributes to the diversion of wastes from landfills and incinerators by encouraging the use of lesser materials in the design, manufacture and packaging of products. EPR also assists municipalities and local governments to cut costs related to the collection, treatment and disposal of waste thereby freeing up resources which can be invested in other areas. Furthermore, the implementation of EPR as a policy tool may lead to sustainability in the production process and contribute to reducing or eliminating toxic and hazardous chemicals in products (OECD, 2001).

Conversely, critics argue that the implementation of EPR can have an impact on trade as well as a stifling effect on technological development (Levy, 2000). EPR may also lead to high cost of products that are ultimately passed on to consumers (OECD, 2001). In order to

[13] Also known as 'product stewardship'

ensure effective implementation of the EPR concept, the OECD provides a set of guiding principles (see table 2.4).

Table 2.4: OECD guiding principles for applying EPR.

1. EPR policies and programs should be designed to *provide producers with incentives* to incorporate changes upstream at the design phase in order to be more environmentally sound.
2. Policies should stimulate *innovation* by focusing more on results than on the means of achieving them - thus allowing producers flexibility with regard to implementation.
3. Policies should take into consideration a *life cycle approach* so that environmental impacts are not increased or transferred somewhere else in the product chain.
4. *Responsibilities* should be well defined and not be diluted by the existence of multiple actors across in the product chain.
5. The *unique characteristics and properties* of a product, product category or waste stream should be factored into policy decisions. Given the diversity of products and their different characteristics, one type of program or measure is not applicable to all products, product categories or waste streams.
6. The *policy instrument(s)* selected should be flexible and chosen on a case-by-case basis, rather than setting one policy for all products and waste streams.
7. Extension of producer responsibilities for the product's life cycle should be done in a way to *increase communication* among the actors in the entire product chain.
8. A *communication strategy* should be devised to inform all the actors in the product chain, including consumers, about the program and to enlist their support and co-operation.
9. To enhance a program's acceptability and effectiveness, a *consultation of stakeholders* should be conducted to discuss goals, objectives, costs and benefits.
10. *Local governments* should be consulted in order to clarify their role and obtain their advice concerning the program's operation.
11. Both *voluntary and mandatory approaches* should be considered with a view on how to best meet national environmental priorities, goals and objectives.
12. A *comprehensive analysis* of the EPR program should be made (e.g. which products, product categories and waste streams are appropriate for EPR, whether historical products should be included, and the roles of the actors in the product chain).
13. EPR programs should undergo periodic *evaluations* to ensure that they are functioning appropriately and are flexible enough to respond to these evaluations.
14. Programs should be designed and implemented in a way that environmental benefits are obtained while domestic *economic dislocations* are avoided.
15. The process of developing and implementing EPR policy and programs should be based on *transparency*.

2.10 Life Cycle Assessment (LCA)

A life cycle assessment[14] (LCA) is a strategy designed to evaluate the environmental impacts of a product beginning from the extraction of raw materials, production and disposal (Horne *et al.,* 2009). The fundamental objective of LCA is to weigh the environmental cost of a product throughout its life-cycle with a view of selecting a less burdensome option (Guinee, 2002). In this process, the life cycle of a product is measured in terms of extraction of raw materials, refinement and conversion to process materials, manufacturing and packaging processes, transportation and distribution at each stage and operation or use during its lifetime. A typical LCA follows a deliberate process of compiling inventory of relevant inputs and outputs as well as the evaluation of potential environmental impacts (Hill, 2005). Input evaluation entails an assessment of energy flow as well as resources utilized in the process. Outputs refer to energy, liquid discharge, waste generated and emissions into the atmosphere (Ibid, 2005). LCA assists with the selection of relevant indicators for environmental performance is one of the major benefits of a LCA process. This can contribute to informed decision making by various stakeholders including, government and industry. LCA may also contribute to improving the life cycle of products while minimizing environmental impacts. Furthermore, proponents argue that LCA allows industry to make environmental claims such as "ecolabelling" which attracts consumers. On the other hand, critics assert that LCA is a complex, subjective and value-laden process (Hackett, 2001). Consequently, rather than objective decisions, choices may be grounded in the aims and objectives of the person(s), group(s) or industries concerned. Therefore, determining what is acceptable raises difficult questions. In order to address these concerns, it is essential that value judgments are clearly identified and transparent. There must be no preconceptions if the desired outcome is a realistic assessment. Each and every phase of the investigation relating to life cycle assessment or analysis must be carefully examined to ensure success.

[14] Sometimes referred to as life cycle analysis, ecobalance or cradle-to-grave analysis

2.11 Waste-to-Energy (WTE)

Waste to Energy[15] (WTE) entails the process of combusting waste under controlled conditions as a means of recovering energy in the form of electricity or heat. The concept is believed to have originated from Europe, from where it spread to Asia and North America (Rogoff, 1987). In the past, mass-burn incineration technology has been the main method for recovering energy from waste. In recent years, several technologies have evolved that aids the energy from waste recovery process. These include pyrolysis, gasification and anaerobic digestion (Porter, 2002; Young, 2010; Sorensen & Breeze, 2009). WTE initiatives reduce the volume of waste by as much as 90%, thereby easing the pressure on landfills (Sorensen & Breeze, 2009). WTE plants also have the potential to generate employment. In addition, the energy recovered during the WTE process can be marketed and the proceeds used for offsetting capital, operational and maintenance costs (Rogoff & Screve, 1987). Notwithstanding its benefits, there are several challenges associated with the WTE concept chief amongst which include the discharge of dioxins and heavy metals into the environment (Sorensen & Breeze, 2009). The financial cost of constructing, operating and maintaining a WTE plant is also seen as a major hurdle (Sorensen & Breeze, 2009). In spite of such challenges, the concept of WTE has gained traction in the waste management concept.

2.12 Summary of Chapter

This chapter has analyzes the major concepts, tools and approaches to waste management. Demonstrably, waste management is a complex process that elicits major concerns around the environment and public health. This is mainly due to the polluting effects of the most widely utilized methods - landfilling and incineration. In response, the waste management hierarchy evolved as a cynosure for selecting techniques considered to be less harmful to environmental and human health. The emphasis on reduce, reuse and recycle (the 3Rs) within the waste management hierarchy was embraced as suitable alternatives to

[15] Also known as Energy from Waste (EFW)

the dominant options of landfilling and incineration. However, the waste management hierarchy fails to effectively address how socio-economic and political barriers to the 3Rs might be tackled. Such excesses catapulted the integrated approach to a level of prominence in the waste management discourse. The IWM approach considers the socio-economic, technical, environmental as well as political of waste management techniques and decisions. This has ensured some success although major challenges still remain, attesting to the complexity of waste management.

Chapter 3

Biomedical Pollutants from Healthcare Activities

3.1 Introduction

The purpose of this chapter is to review the state of science in regards to biomedical pollutants generated during the course of healthcare activities. The discussion centres on the types, sources and approaches to managing biomedical pollutants. Pertinent questions to be addressed in the chapter include: What are biomedical pollutants? Where are the main sources of biomedical pollutants? Which types of biomedical pollutants are known to constitute a threat to the environment and/or human health? What is known scientifically about the risks posed by biomedical pollutants? What are the appropriate steps to managing biomedical pollutants? Which of the waste management techniques highlighted in the previous chapter are suitable for managing biomedical pollutants?

3.2 Types and Sources of Biomedical Pollutants

Biomedical pollutants refer to the types of potentially infectious, toxic and hazardous wastes generated in healthcare facilities, research institutions and microbiology laboratories during the diagnosis, treatment and immunization of humans and animals (Burke, 1994; CCME, 1992; Etter *et al.*, 1992; Rutala & Weber, 1991; Socunya, Matias & Lapid, 1997). Such pollutants can be classified in two main categories: hazardous Infectious and hazardous non-infectious. Infectious-hazardous BMW typically contains pathogens such as bacteria, fungi, viruses and parasites in sufficient concentrations to cause diseases to a potential host (US Department of Health report, 1990; Burke, 1994 Klangsin & Harding, 1998). Infection typically occurs when there is a sufficient dose, the presence of infectious agents, a portal of exit, a mode of transmission, a portal of entry and a susceptible host (CCME, 1992; Pruss *et al.*, 1999). Examples of infectious biomedical pollutants include discarded human/animal pathological parts and organs, microbiology laboratory wastes, human blood, body fluids and sharps objects as well as materials and accessories that come into contact with such wastes

(CCME 1992, WHO, 2007; Pruss *et al.*, 1999). Table 3.1 & 3.2 illustrates the types, composition and main sources of hazardous-infectious and hazardous non-infectious types of biomedical pollutants.

Table 3.1: Types, composition and main sources of hazardous-infectious biomedical pollutants

Types	Composition	Main Generating sources
Human/animal anatomical waste	Tissues Organs Body parts (excluding teeth, hair and nails) Carcasses Bedding Items or body fluids contaminated with blood	Operating theatres and surgical wards Veterinary Clinics/hospitals
laboratory waste	Lab/microbial cultures Live/attenuated vaccines Human or animal cell cultures Specimens of micro organisms Body fluids of patients with	Laboratories
Human blood/body fluid	Human blood Body fluid Blood products Body fluids contaminated with blood Used absorbent material saturated with blood, body fluids or excretions contaminated with blood. E.g., bandages, gauze and sponges	Medical wards/laboratories Maternity Homes Mortuary and autopsy centres Traditional birth attendants Underground abortion clinics Traditional circumcision experts Traditional healing centres
Sharps	Needles/syringes/blades/knives/scalpels Glass capable of causing cuts or punctures	Physicians offices Home healthcare Psychiatric wards Hospitals, clinics, (Poly)clinics Family Planning Units

Adapted from Pruss et al., 1999

Table 3.2: Types, compositions and main sources of hazardous non-infectious biomedical pollutants

Type	Composition	Sources
Pharmaceutical wastes	Expired, unused, spilt and contaminated pharmaceutical products, drugs, vaccines and sera Bottles gloves, vials and masks used for disposing pharmaceutical waste	Hospitals Clinics Nursing homes Family Planning Clinics Maternity Homes Home care Psychiatric Facilities Mobile Health Care Units
Hazardous Chemical waste	Formaldehyde Photographic chemicals Expired disinfectants Solvents	
Genotoxic/cytotoxic waste	Vomit, urine or faeces from patients treated with cytostatic drugs, chemicals and radioactive material. Antineoplastic Chemotherapy agents	Home healthcare Cancer treatment facilities Hospitals hospices
Radioactive waste	Liquids, gas and solids contaminated with radionuclide e.g., x rays, g-rays, a and b particles Unused Liquids from radiotherapy or laboratory research Contaminated glassware, packages or absorbent paper	X- Ray Departments Laboratories
Wastes with high content of heavy metals	Mercury from dentistry Cadmium from discarded batteries Arsenic drugs Spillage from broken clinical equipment e.g., thermometers, blood pressure gauges.	Dentistry
Pressurized containers	gas cylinders, cans	

Adapted from Pruss et al., 1999

As demonstrated in table 3.2., hazardous non-infectious biomedical pollutants consist of discarded materials from healthcare activities that are not infectious but can nonetheless cause injury or damage to humans and the environment. Examples of such pollutants include discarded chemical, pharmaceutical and genotoxic residue as well as containers and materials used in the storage of such products are considered as BMW (Pruss *et al.*, 1999; Socunya, Matias & Lapid, 1997). Other types of BMW include pressurized containers, radioactive residue as well as wastes with high content of heavy metals such as mercury (Etter *et al.*, 1992; Rutala & Weber, 1991; Socunya *et al.*, 1997, Matias & Lapid, 1997; Pruss *et al.*, 1999).

3.3 The Management of Biomedical Pollutants

The management of biomedical pollutants can be described as a multifaceted process that typically involves effective legislation, training, minimization, proper handling, segregation, storage, transportation, treatment and safe disposal (Pruss *et al.*, 1999; Socunya, Matias & Lapid, 1997; Rao *et al.*, 2003; WHO, 2007). An extensive analysis of the key approaches to managing biomedical pollutants constitutes the essence of this section.

3.3.1 Legislative & Regulatory Arrangements

Regulations are a central part of biomedical waste management processes. At the global stage, regulations pertaining to the management of biomedical pollutants are contained in a number of frameworks including the Polluter-Pays-Principle (PPP), the Proximity Principle, the Precautionary Principle, and the Basel Convention. The *PPP* places the legal and financial responsibility of disposing hazardous pollutants on generators of such wastes, while the proximity principle addresses the need to dispose hazardous wastes close to the point of generation. The need to take effective management action to mitigate risks posed by hazardous wastes in the absence of scientific certainty constitutes the essence of the precautionary principle. On its part, the Basel Convention addresses the issue of trans-boundary movement of hazardous wastes such as, biomedical pollutants.

In addition to these global frameworks, many countries have well defined and established guidelines regulating the management of biomedical pollutants. In Canada for instance, regulations governing the management of such pollutants are embodied in a number of federal, provincial and municipal statutes. These include the Environmental Management and Protection Act, (2002); The Municipal Refuse Management Regulations, The Water Regulations (2002); The Clean Air Act and Regulations and the Occupational Health and Safety Act and Regulations (CCME, 1992). Similarly, the management of biomedical pollutants in countries including the United States, Japan, Taiwan Korea as well as the European Union are regulated by national and local legislations (Chang, 1995; Jang, 2006; Kizlary *et al.*, 2005; Lee & Huffman, 1996; Miyazaki & Une, 2005; Muhlich *et al.*, 2003). Violators of regulations pertaining to the management of biomedical pollutants are often held legally liable. In Saskatchewan for example, "persons found in contravention of the Environmental Management and Protection Act, 2002 and Regulations made pursuant to the Act may be subject on conviction to a fine of not more than $1,000,000, to imprisonment for not more than 3 years or both" (Government of Saskatchewan, 2008). Such penalties are designed to ensure adherence to policy.

Internal regulations aimed at ensuring the safe management of biomedical pollutants at the points of generation is also a cardinal feature of the biomedical waste management process in many developed countries. In Canada, facilities and organizations responsible for handling and disposing BMW are required to take reasonable steps to reduce the risk of infection exposure to personnel (CCME, 1992). This must be done with the establishment of written policies and procedures based upon the most currently accepted clinical and occupational health and safety information (Ibid. 1992). These requirements are in line with the stipulations of the Canadian Labour Code which requires employers to provide safe working environments to employees and provide information regarding occupational hazards associated with their responsibilities (Ibid. 1992).

Thus, effective legislations and regulatory arrangements are essential to the attainment of successful outcomes in the management of biomedical pollutants. Such

regulations must be backed with effective enforcement to ensure compliance. Conversely, weak and feckless legislative arrangements may result in ineffective management practices which may lead to adverse environmental and human health consequences.

3.3.2 Training

Another important step in the biomedical pollutant management process is the need for knowledge, skill and attitude based training to stakeholders including healthcare personnel, transporters, incinerators and landfill operators (CCME, 1992; Pruss *et al.*, 1999; WHO, 2007).

Table 3.3: Recommended training regimen for handlers of biomedical pollutants.

Generators	Incineration operators	Landfill Operators	General Public
Safe handling Use of protective equipment Segregation Use of colour coded bags and/or containers Storage Prevention of public access Maintenance of security Transportation Use of protective equipments Health hazards Disinfection Disposal Prior treatment Safe Disposal	**Waste handling** Safe receiving, handling, storage and loading techniques **Plant Operation** Safe removal of ashes and residues Detection of defects and malfunctions Operation of the plant **Maintenance** Inspection, cleaning, lubrication, Replacement Overhauls **Safety and Emergency** Use of protective equipment Contingency plans during breakdowns and maintenance Dealing with spillages accidents and other unforeseen incidents **Administrative Procedures** Record keeping License/regulations Reporting of accidents	**Waste handling** Use of protective equipment **Plant Operation** Health hazards Safe procedures for landfill operation Procedures for emergency response	Public education Awareness Health hazards

Adapted from Pruss et al., 1999

3.3.3 Minimization of Biomedical Pollutants

Minimization of biomedical pollutants is deemed a vital step in the management process and can save costs associated with disposal (Hedge *et al.,* 2007). One way of achieving minimization is through the implementation of strict source reduction rules, good stock management practices as well as reuse and recycling of equipment (Chandra *et al.,* 2006; Pruss *et al.,* 1999). Recycling is also another step that can be taken to ensure waste minimization and reduction (Lee *et al.,* 2002). However, due to infection and contamination concerns, materials that can be reused or recycled are restricted.

3.3.4 Handling of Biomedical Pollutants

Safe and proper handling of biomedical wastes is essential to mitigating adverse health effects among frontline staff (Pruss *et al.,* 1999). Unsafe handling is more likely to cause problems such as blood borne pathogens to the groups at highest risks: namely healthcare staff, scavengers and municipal workers Soliman and Ahmed (2007). A strict adherence to policy and procedure is advocated during the handling of biomedical wastes. Such procedures include wearing protective gear like gloves and masks (Pruss *et al*., 1999).

3.3.5 Segregation

In order to avoid environmental contamination and human health infection, segregation of biomedical pollutants from non-pollutants is touted as a necessary management procedure (Oke, 2008; Rao *et al.,* 2004). Segregation must take place at the point of generation or in close proximity (Pruss *et al*., 1999). Segregated BMW is usually placed in designated color-coded bags or containers and properly labelled for easy identification (CCME, 1992).

3.3.6 Storage

Safe and secured storage of biomedical pollutants is essential for the mitigation of risks to the environment and public health. Subsequently, generators and waste managers must have designated facilities for storing such pollutants prior to final disposal. The

recommended storage period for biomedical pollutants must not exceed more than three days during the winter season, and two days in the summer time (Pruss *et al.*, 1999). In warm and tropical countries, the recommended storage time frame is two days in the cool season and one day during the hot season (Ibid. 1999). For certain classes of biomedical pollutants such as, cytotoxic and radioactive wastes, special storage procedures are necessary due to its high levels of toxicity (Govt. of NWT, Guidelines 2005; Govt. of Ontario, EPA Act, 1990; Pruss *et al.*, 1999).

3.3.7 Collection and Transportation

Regular collection and safe transportation of biomedical pollutants is considered a necessary and integral aspect of the management process. Such pollutants must be transported at the points of generation and to final disposal sites by means of designated trolleys, containers, carts and motorized vehicles (Govt. of NWT, Guidelines 2005; Govt. of Ontario, EPA Act, 1990; Pruss *et al.*, 1999). It is recommended that vehicles used for transporting biomedical pollutants must be cleaned and disinfected regularly to prevent infection and contamination (Pruss *et al.*, 1999).

3.3.8 Treatment Methods

Treatment of biomedical waste (BMW) entails a process of altering the biological and chemical characteristics of such wastes to render it non-toxic, non-hazardous or non-infectious (Oke, 2008). Recommended options for treating BMW include steam autoclaving, chemical disinfection, microwave irradiation and incineration[16] (CCME, 1992; Pruss *et al.*, 1999).

3.3.8.1 Steam Autoclaving

Steam autoclaving involves exposing infectious waste to high temperature and high pressure steam as a way of inactivating infectious microorganisms (Pruss *et al.*, 1999). It is

[16] Incineration as a waste management method has been thoroughly discussed in the previous section.

regarded as an appropriate method for treating infectious non-anatomical wastes, sharps and microbiology laboratory wastes (CCME, 1992). It is highly recommended that wastes are shredded before treatment in a steam autoclave (Ibid. 1999). The process is considered one of the most cost-effective options for treating BMW.

3.3.8.2 Chemical Disinfection

Chemical disinfection entails adding chemical solutions to biomedical pollutants with the objective of killing or inactivating pathogens (CCME, 1992; WHO, 2000). This type of treatment option is ideal for treating liquid biomedical wastes such as blood, urine and hospital sewage (CCME, 1992). It is also ideal for treating most infectious biomedical wastes except anatomical wastes (Ibid. 1992).

3.3.8.3 Microwave Irradiation

Microwave irradiation with a frequency of about 2450 MHz and a wave length of 12.24cm is the most common dry thermal treatment option for treating infectious BMW (Pruss *et al.*, 1999). Microwave irradiation allows for the liquid contained in infectious waste to be heated and consequently destroyed (Pruss *et al.*, 1999). Other treatment options for biomedical waste (BMW) include encapsulation, cement encasing and point of use needle destruction technologies (Emmanuel *et al.*, 2002; Pruss *et al.*, 1999).

3.3.8.4 Safe on-site Burial

On-site disposal of biomedical waste at generation points is recommended as a suitable option especially in developing countries (Pruss *et al.*, 1999). However, in cases where on-site burial is carried out, the burial site must be restricted to authorized personnel and also, adequate steps must be taken to prevent pollution and contamination of ground and surface water sources (Pruss *et al.*, 1999). Precautionary steps that may be taken during on-site burial of BMW include lining burial grounds with clay and other materials to prevent penetration into the ground (CCME, 1992; Pruss *et al.*, 1999). Furthermore, infectious and

hazardous residues must be encapsulated with immobilizing agents prior to burial. A summary of recommended treatment and disposal options for BMW is illustrated in table 3.4.

Table 3.4: Recommended treatment and disposal options for biomedical pollutants

Types of BMW	Large quantities	Small quantities
Human anatomical waste	Incineration Safe on-site burial	Same as large quantities
Animal waste	Incineration Safe on-site burial	Same as large quantities
Microbiology laboratory waste	Incineration Chemical disinfection Wet thermal treatment Microwave irradiation Sanitary landfills	Same as large quantities
Sharps	Chemical disinfection Incineration Encapsulation Microwave irradiation Safe on-site burial Wet thermal treatment	Same as large quantities
Pharmaceutical waste	Encapsulation Inertization	Safe on site burial Discharge to sewer landfill RTOS Incinerator
Chemical waste	Return to Original Supplier (RTOS)	Incineration Encapsulation Safe on-site burial RTOS
Cytotoxic waste	RTOS Inertization Oxidization by potassium permanganate ($KMnO_4$), sulphuric acid (H_2SO_4)	Encapsulation
Radioactive waste	RTOS Safe storage in a designated facility	Same as large quantities
Waste with high content of heavy metals	TOS Recycle Safe storage sites	
Pressurized containers	RTOS Reuse, recycle	

Adapted from Pruss et al., 1999

3.4 Risks Associated with BMW

Biomedical pollutants elicit major concerns around environmental and public health. An assessment of some of these major risks is the focus of attention in this section.

3.4.1 Public Health Risks

Biomedical pollutants pose major threats to public health. Pathogenic microorganisms contained in such pollutants may enter the human body primarily through ingestion and inhalation (Burke, 1994; Klangsin & Harding, 1998; Govt. of NWT, Guidelines, 2005; US Department of Health report, 1990). Human exposure to contaminated blood and body fluids can cause infections due to the possible presence of blood or liquid-bourne pathogens (Diaz *et al*., 2005; Socunya, Matias & Lapid, 1997; Pruss *et al*., 1999). Infections can also be caused by sharp objects contained in BMW such as, used needles, syringes, blades, knives, saws, scalpels or glass materials. Sharps-related infections have received considerable amount of attention in the literature. The World Health Organization (2006) reported that injections with contaminated syringes was responsible for 32% of new hepatitis B (HBV) virus infections, 40% of hepatitis C virus (HCV) infections and 5% of all new HIV infections in the year 2000. In the United States, it is estimated that 0.01% of all reported AIDS infections in 1992 were caused by accidents involving sharps in biomedical wastes (US Department of Health and Human Services, 1996). In Japan, Miyazaki *et al.* (2007) had noted that accidents involving sharps are prevalent in municipal governments. Chandra & Shishoo (2001) also observed that in India, more than 20% of people who handle sharps encounter “stick” injuries. Mato and Kaseva (1997) also reported on the prevalence of injuries among healthcare workers during the collection of biomedical wastes in Tanzania. A study by Gisselquist *et al.* (2003) suggests that in Africa, healthcare-related infections may be a major contributing factor for the spread of HIV. In addition to causing infection, sharps in biomedical wastes can cause accidental inoculation regardless of whether they are infected or contaminated (Tamplin *et al.*, 2005).

Hazardous non-infectious types of BMW also pose major risks to public health. Radioactive residue can cause ionization of intracellular proteins and protenaceous

components in the human body (Pruss *et al.,* 1999). Certain types of cytotoxic drugs also have the ability to stop or kill the growth of certain living cells (Ibid. 1999). Additionally, wastes with high contents with heavy metals including mercury in dental amalgam, lead and silver produced in dental X-rays can have neurotoxic and nephrotoxic effects on human health by interfering with metabolic processes (Hedge *et al*., 2007; Perben, 2004). These can also affect neurological development and functions in humans (Hedge *et al*., 2007). Furthermore, chemicals used during cleaning and disinfection may also cause headaches, fatigue, dizziness, respiratory infections as well as injury to the skin, eyes or mucous membranes (Pruss *et al*., 1999; Socunya, Matias & Lapid, 1997). Some of such chemicals may be corrosive, flammable and genotoxic. Some chemical residues can affect the liver, blood and kidneys and nerve system in the human body (Griffin, 1990). Finally, pressurized containers may explode if incinerated or accidentally punctured (Ahmed, 1997).

3.4.2 Environmental Risks

Improperly disposed biomedical pollutants may end up in surface, ground and drinking water sources (Tsai *et al.,* 1998). This can have a negative impact on aquatic life in terms of reproduction and development (Fong, 1998; Jobling *et al.,* 1998). In Accra, Ghana for example, Boadi and Kuitunen (2002) had suggested that the improper disposal of untreated biomedical pollutants contributed to the loss of aquatic life in the Korle Lagoon ecosystem. The feminization of male fishes in some British rivers due to exposure to low levels of oral contraceptives also stands out as another example of the risks posed by biomedical pollutants to ecosystems (Jobling *et al.,* 1998; Larson *et at.,* 1999). Furthermore, under conditions of mismanagement, human and animal anatomical parts contained in BMW may cause environmental nuisance and attract disease causing vermin (Nemathaga, Maringa & Chimuka, 2007). This has been observed in some parts of India where pathological wastes including amputated human body parts are mixed with regular waste and dumped in unsanitary landfills (Gupta & Boojh, 2008). Despite the risks posed by biomedical pollutants to the environment, a paucity of information regarding cause and effect relationships contributes to high degrees of uncertainty (Muhlich *et al.,* 2003).

3.5 Summary of Chapter

This chapter has discussed the types, composition and sources of biomedical pollutants. The chapter also examined approaches to the management of biomedical pollutants including the roles of legislations and training as well as the application of effective treatment methods. As part of the discussions, environmental and human health risks associated with the different classes of biomedical pollutants were analyzed.

Chapter 4

The Management of Urban Wastes and Biomedical Pollutants in Developing Countries: A Critical Review of the Literature

4.1 Introduction

Waste management is arguably the single most daunting environmental challenge facing many developing countries. Why is this the situation? What is the extent of the problem? How is the problem being addressed and by whom? This chapter examines the waste management situation in developing countries. An assessment of the amount and main characteristics of wastes generated is presented in section 4.2 and 4.3 respectively. In section 4.4, the roles of the public, private and informal sectors in waste management service delivery are critically analyzed. This is followed by an extensive assessment of waste management practices in section 4.5. The environmental and human health risks associated with current waste management is highlighted in section 4.6. In section 4.7, the management of biomedical pollutants is examined. The underlying causes of the precarious waste management situation are discussed in section 4.7. A summary of the discussion is provided in section 4.8.

4.2 Waste Generation Rates

A review of the literature suggests that many developing countries generate massive volumes of wastes on a regular basis (Alam *et al.,* 2008; Kironde, 1999; Onibokun & Kumuyi, 1999). Urban areas in Asia reportedly generate in excess of 760,000 metric tonnes of wastes on a daily basis (Hoornweg & Thomas, 1999) while Latin American cities generate 240, 000 metric tonnes daily (Moreno *et al.,* 1999). Approximately 2,614,904 metric tonnes was generated in the Iranian capital city of Tehran in 2004 (Dambghani *et al.,* 2008). It is estimated that by the year 2030, urban waste generations rates in China will be at least 485 million tonnes annually, representing a 214% increase from 2004 (OECD, 2008). In urban India, waste generation rates will reportedly reach 250 million tonnes annually by 2030, an

increase of 130% from 2001 (Ibid. 2008). In Kathmandu Nepal, 245 metric tonnes of waste is produced daily (Alam *et al.,* 2008) while in Lagos, waste generation rates in 1982 was 625, 000 metric tonnes (Onibokun & Kumuyi, 1999).

4.3 Composition of Wastes

There tend to be a paucity of information regarding the composition of wastes generated in developing countries due to poor record keeping or the lack thereof. However, available data in the literature indicates that the wastes generated in developing countries typically have high contents of putrescible organic matter, moisture and density with less recoverable materials (Blight & Mbande, 1998; Cointreau, 1982; Diaz *et al.,* 2005). A major reason for the high presence of putrescible organic matter is due to low rates of industrialization as well as relatively large agro-based economies especially in sub-Saharan Africa.

4.4 Major Actors involved in Waste Management Service Delivery in Developing Countries

Waste management service delivery in developing countries is facilitated by three principal actors: the public, private and informal sectors. An analysis of the roles of each actor is the focus of discussion in this section.

4.4.1 The Public Sector

The public sector approach typically involves central governments entrusting legal responsibilities pertaining to waste management to municipalities and local governments (*see for example,* Ali *et al.,* 1999; Bubba & Lamba, 1991; Cointreau, 1982; Gidman *et al.,* 1995; Gilbert *et al.,* 1996; Oluwande, 1984; Van de Klunkert & Lardinois, 1994:7). Operational resources are provided by central governments, while user charges and municipal taxes provide extra funding. The public sector approach is predicated on an economic argument that holds a view of the market or private sector as incapable and ill-equipped to provide urban services such as waste management (Brown & Jackson, 1990; Walsh, 1995).

Subsequently, proponents of the public sector mode of service delivery assert that governments are better equipped to provide urban services through regulations, budgets and subsidies (Jones *et al.,* 1980). Theoretically, this can lead to the provision of low cost service delivery while improving efficiency. However, a review of the literature suggests that the public sector approach is laden with some major problems. The concentration of power in the hands of government has been shown to lead to excessive bureaucracy, political interference, corruption and mismanagement (Chapman, 1979; Hatry, 1983; Niskanen, 1971; Walsh, 1995). In some areas, the public sector approach has resulted in high operational costs and absorbs almost 50% of municipal budgets (Cointreau, 1994). Countries in Asia reportedly spend a significant $25 billion each year on waste management (Hoornweg & Thomas, 1999), although this has not led to any significant improvement in the general waste management situation. Notwithstanding its excesses, the public sector approach remains the most dominant in developing countries.

4.4.2 Private Sector Participation

In the last few decades, private sector participation (PSP) in waste management service delivery has become a major feature in many developing countries (Bartone, *et al.*, 1991; Batley, 1996; Kironde, 1999; Majani, 2000; Obirih-Opareh & Post, 2002; Ogu, 2000). The prominence of the private sector can be attributed to a number of factors including the excesses of the public sector approach and its resultant failures. In many African and Latin American countries, PSP evolved as a result of economic reforms notably, structural adjustment programs (SAPs) imposed by international financial institutions as a precondition for obtaining new loans or lowering interest rates on existing debts (Ogu, 2000). Typically within the private sector approach, local governments and municipal councils contract out all or some aspects of waste management service delivery to local and international business entities (see for example, Attahi, 1999; Baud *et al.*, 2000; Lapid, 1999; Moreno, *et al.*, 1999).

Proponents tout private sector participation as the key to ensuring low cost, efficiency, competition as well as the provision of funds for capital investment (Bartone, Bernstein & Wright, 1990; Blais & Dion, 1992; Diaz *et al.*, 2005; Jackson, 1982). For

supporters of the private sector, ownership is central to better performance, the lack of which accounts for the poor performance of the public sector (Abu Shair, 1997; Davies, 1981; Hodge, 2000). The private sector is also seen as having access to financial resources that can be used to hire and retain experts, procure equipment and technology and bring down costs due to competition (Zhu *et al.*, 2008). Furthermore, the private sector is seen as less prone to political interference and has the capacity to reward performance among staff and fire underperforming personnel (Blight and Mbande, 1998; Zhu *et al.*, 2008).

In many developing countries however, PSP in waste management service delivery has not led to significant improvements in the waste management situation. In Benin City Nigeria for example, the involvement of the private sector in waste management service delivery was initially successful but became a problem when user-charges soured amid cuts in services due to rising operating costs and vehicle maintenance (Ogu, 1996). Similarly, in Nairobi, Kenya, it has been reported that privatization of waste collection has seriously weakened the economic viability of the system due to the engagement of companies in uncoordinated competition to provide services for scattered clients (Baud, Post & Furedy, 2004). In Lahore, Pakistan, some private contractors involved in waste management service delivery withdrew from the program prior to the end of their contract for unknown reasons (Ahmad, 2003). Furthermore, a strong private sector in juxtaposition to a weak public sector may result in unbalanced partnership and subsequently, monopoly, which can lead to increase in costs as well as inefficient delivery (Zhu *et al.*, 2008). Since the aim of every entrepreneur is to maximize profits, the private sector can also resort to labour exploitation as a means of cutting costs. This can result in a lack of motivation and morale among personnel and can lead to inefficiency.

4.4.3 The Informal Sector

The role of the informal sector in waste management service delivery in developing countries is not nascent. For decades, the informal sector had supplemented the service delivery process by covering areas neglected by the formal sector approach such as slums and squatter settlements. Informal sector activities have evolved around street sweeping,

waste collection and recovery (Adeyemi, Olurunfemi & Adewoye, 2001; Beukering *et al.*, 1999; Korfmacher, 1997; Medina, 1997). In Karachi, Pakistan, the informal sector is reported to reduce municipal waste collection by as much as 10% (Ali *et al.*, 1998). Historically, 40% of organic wastes generated in the Pakistani city of Lahore has been collected by livestock farmers (Cointreau, 1982). In Mexico, it had been estimated that 10% of municipal waste is collected by scavengers (Bartone, 1991), while in Bangalore, India 15% of waste was recovered by the informal sector (Baud & Schenk, 1994). An estimated 2% of the total volume of waste generated in the Kenyan capital city of Nairobi was collected by scavengers in the early 1990s (Syagga, 1992).

Thus, the informal sector play a crucial role in regards to waste management service delivery in developing countries. Despite a paucity of information on current data, historical figures show that an estimated 2% of the population in developing countries are dependent on the recovery of waste for survival, collecting 5-15% of the total volume of wastes (Bartone, 1988; Chifos & Romanos, 1996; Cointreau, 1989). In Dakar, Senegal, some 200,000 people were believed to be employed in the informal recycling sector (Waas & Diop, 1991). Such high figures demonstrate the prominence of the informal sector in waste management service delivery in developing countries.

4.5 Waste Management Practices in Developing Countries

Waste management service delivery in many developing countries has historically been predicated on the conventional approach (see chapter 2) which typically involves the collection and disposal of waste with little or no emphasis on minimization, recovery and recycling (Cointreau, 1982). This approach entrusts waste management functions to local governments and municipalities while funding is generated both internally and externally (Ali *et al.*, 1999; Bubba & Lamba, 1991; Cointreau, 1982; Gidman *et al.*, 1995; Gilbert *et al.*, 1996; Oluwande, 1984; Van de Klunkert & Lardinois, 1994). A review of the literature reveals that the reliance on the conventional approach has largely failed. Such failures are manifested in the waste management practices in many developing countries. This section

examines waste management practices in developing countries with a focus on collection, transportation, service delivery, incineration and disposal.

4.5.1 Poor Waste Collection Practices

Poor collection of waste has been reported in many developing countries. In Nepal for example, an estimated 13.5 million tonnes of waste generated in the country are left uncollected (Alam *et al.*, 2008). The situation is no different in sub-Saharan Africa where collection rates have been reported to be in the range of 30-50 % (Obeng & Cointreau, 1997; Paris, 2000; Post, 1999). Latin America cities such as Caracas, Lima, Managua and San Salvador have a waste collection rate of 40% in low income areas (Moreno, 1999). In Bangkok, (Thailand) and Manila (Philippines), between 20-30% of waste is left uncollected (Wilson & Nair, 1992:82). In Afghanistan, Amanullah (1995:1) has noted that: "it is not uncommon for garbage to sit at a transfer point for two to three months before being transported to the dumpsite". Similar conditions have been noted elsewhere (see for example, Ayininuola & Muibi 2009; Musandu-Nyamayaro, 1991; Onibokun & Kumuyi, 1991; Talyan, Dahiya & Sreekrishnan, 2008). In Limbe, Cameroon, waste is left uncollected for long periods of times by roadsides, providing dwelling for disease causing vermin (Manga *et al.*, 2008)

4.5.2 Transportation

As a result of limited financial resources many developing countries do not have access to reliable waste collection vehicles and equipment. Describing the situation in Kathmandu, Nepal, Alam *et al.* (2008) notes:

> It is a normal phenomenon for vehicles to break down at anytime. Moreover, the spare parts of German donated vehicles are expensive and not readily available in the local market. Similarly, the hydraulic systems of a compactor and dumper placer donated by the Indian Government are also out of service. In fact, there is a long list of vehicles requiring immediate repair. At any given moment, ten vehicles sit at the workshop awaiting repair and maintenance, whereas the workshop can barely handle six at a time.

Similar conditions have been observed elsewhere. In Dar es Salaam, Tanzania, although the city requires 240 trucks to collect wastes only 30 are available (Mosha, 1990). A similar observation has been made in Ibadan, Nigeria, where close to half of the trucks used for waste collection are inoperable (Onibokun & Kumuyi, 1999). Consequently, the use of donkey carts, handcarts, tricycles and head pans for transporting wastes have been reported in many developing countries (Korfamcher, 1999; Moreno et al., 1999; Pfammatter & Schertneib, 1996).

4.5.3 Inequitable Delivery of Services

It has been reported that waste collection tends to be much more efficient in affluent areas in developing countries than in middle and low income areas (Cointreau, 1982; Leduka, 1991; Mwafongo, 1991; Ogu, 2000; Post, 1991; Wilson & Nair, 1992). A major reason that accounts for inequitable delivery of waste management services is due to a tendency on the part of service providers especially those within the private sector, to operate in rich and affluent areas where residents are more likely to pay for services. Inequitable delivery of services also tend to be more pronounced in slums, squatter, informal settlements and densely populated areas where large waste collection vehicles are unable to navigate due to poor road networks (Blight & Mbande, 1998). Inequity has also been observed in the location of waste management dumps (Silitshena, 1996). In China for example, nearly half of the 113 million tonnes of waste generated in China are dumped in poor suburbs (Wang & Nie, 2001). Similar situations have been reported in Bangkok Thailand as well as in Manila, Philippines (Wilson & Nair, 1992).

4.5.4 Rudimentary Incineration, Unregulated and Crude Burning Practices

Incineration technology as a waste management option is severely limited in developing countries due to high operating and maintenance costs (Coker *et al.,* 2009; IECT, 2000; Izugbara & Umoh, 2004). Consequently, most of the incinerators in developing countries are obsolete and operate in a rudimentary manner (Talyan *et al.,* 2008). In parts of South Africa and Tanzania incinerators operate on coal and as a result cannot produce the

temperature necessary for proper burning leading to partial burning wastes (Mato & Kassenga, 1997; Nemathaga *et al.,* 2008). In a another study undertaken in Jordan, Abdulla *et al.* (2008) notes that incinerators are not equipped with a gas cleaning system, contributing to the release of dangerous particles into the atmosphere.

As a result of the lack of incineration technologies in developing countries, crude and unregulated burning of waste is commonplace (Blight & Mbande, 1998). It had been estimated that 18% of households in the Ghanaian capital city of Accra burn their waste (Benneh *et al.,* 1993). In Botswana, crude burning is encouraged and promoted by community health workers as a viable alternative to incineration (Kgathi & Balaane, 2001). In India Gupta and Boojh (2008) observed crude and unregulated burning of biomedical pollutants in healthcare facilities.

4.5.5 Indiscriminate and Open Dumping

Many developing countries lack access to sanitary landfills (Bartone *et al*., 1991; Hoornwerg & Thomas, 1999). Both Nigeria and Botswana for example, have only two sanitary landfills (Agunwamba, 1998; Kgathi & Balaane, 2001) while other African countries have none. The Caribbean Island of Barbados also has one active landfill in the entire country (Headley, 1998). Only a handful of cities in Latin America including Buenos Aires, Santiago, Sao Paolo and Medeline reportedly have access to well managed landfills (Bartone *et al*., 1991; Hoornwerg & Thomas, 1999). Consequently, open and indiscriminate dumping is prevalent in many developing countries (*see for example,* Armstrong, 1993; Bartone *et al.,* 1991; Bassey *et al*., 2006; Hoornwerg & Thomas, 1999; Kgathi & Balaane, 2001; Manga *et al*., 2008; 1997; Nemathaga *et al.*, 2007; Syagga, 1992). In many instances, wastes are disposed indiscriminately on abandoned land, streets, rivers, forests and the ocean (Ayininuola, 2008; Bassey *et al*., 2006; Musandu-Nyamayaro, 1991; Nwaka, 1990; Onobokun & Kumuyi, 1999; Post, 1999; Talyan *et al.,* 2008; White, 1989). In Latin American cities 60% of the wastes generated are disposed of in open dumps (Anand, 2010). In many parts of India for example, wastes from urban areas are commonly disposed in low-lying areas in an uncontrolled manner devoid of environmental considerations (Talyan *et al.,*

2008). Similarly, in Istanbul, indiscriminate disposal of waste into the ocean and open land has been reported (Berkun *et al.,* 2005; Kocasoy, 1999). An estimated 70% of urban wastes generated in Nigeria are indiscriminately dumped in open spaces, rivers and streams (Nwaka, 1990). In some cases, open dumping takes place in close proximity to residential neighbourhoods (Ayininuola, 2008). Similar instances of have been reported elsewhere (see for example, Amanullah, 1995; Asomani-Boateng, 1999; Boadi & Kuitunen, 2003; Ohnesorgen 1993; Osei & Duker, 2008; Post, 1999). Such poor and deplorable waste management situation in developing countries contributes to a host of environmental and human health issues. A cursory assessment of some of these risks is presented next.

4.6 Environmental and Human Health Risks

Poor waste management practices such as infrequent collection, indiscriminate dumping and crude burning practices results in a myriad of risks to the environment and human health. In many developing countries, particularly in Africa indiscriminate dumping of waste has significantly altered the aesthetics of the natural environment (Musandu-Nyamayaro, 1991; Silitshena, 1996). In many areas, waste has caused significant levels of pollution to aquatic ecosystems some of which are sources of drinking water (Boadu & Kuitnenen 2003; Christiansson, 1993; Izeogu, 1989). Such environmental risks often translate to human health problems including cholera, dysentery and floods (Armstrong, 1999; Asomani-Boateng, 1999). In Afghanistan, Amanullah (1995) noted that improper waste management accounts for one of the leading causes of diseases. Ohnesgoren (1993) had also suggested that ineffective waste management practices in Ecuador contributed to the deaths of 37 people in a single month. In Nairobi, Mwanthi *et al.,* (1997) hinted that the prevalence of filth-related diseases such as cholera, paratyphoid and shigellosis are as a result of precarious waste management conditions. Thus, ineffective waste management poses a threat to the environment and human health. Such risks are significantly elevated with biomedical pollutants generated in the course of healthcare activities. An assessment of how such pollutants are managed in developing countries is next.

4.7 The Management of Biomedical Pollutants in Developing Countries

As discussed in the previous chapter, the effective management of biomedical pollutants requires sound legislations, training as well as safe handling, segregation, storage, transportation, treatment and disposal practices. A review of the literature indicates in many developing countries, such procedures are not followed. Consequently, the management of biomedical pollutants in many developing countries is in a similar state of precariousness as regular wastes. Many countries do not have effective legislations for managing biomedical pollutants and where legal provisions exist, compliance and enforcement is largely negligible (Manyele, 2004; Mbongwe *et al.,* 2008; Mclean *et al.,* 2007). This results in ineffective management practices including, lack of training, non-segregation, unsafe storage, lack of treatment, open dumping and crude burning.

4.7.1 Lack of training and non-segregation of biomedical pollutants

Training is often not provided to handlers and generators of biomedical pollutants, contributing to a general lack of awareness and unsafe management practices (Alagoz & Kocasoy, 2008; Askarian *et al.,* 2004; Da Silva *et al.,* 2005; Gupta & Boojh, 2008; Hassan *et al.,* 2008; Mbongwe, *et al.,* 2008; Mato & Kaseva, 1997; Nemathaga *et al.*, 2007). In Tanzania for example, Mato and Kasseva (1999) observed that personnel responsible for handling biomedical pollutants lack the necessary skills and training to carry out their duties. Mbongwe *et al.*, (2008) also observed a lack of training among healthcare workers leading to the disposal of infectious and non-infectious wastes in the same waste bin without segregation. Similar instances of non-segregation of biomedical pollutants have been documented. In a study undertaken in South Africa, Nemathaga *et al.,* (2007) observed that sharps are the only items segregated at the point of collection. A similar situation was uncovered in India where used cotton, dressing materials blood, needles and syringes are not segregated from the general waste pile (Gupta & Boojh, 2008). In Tanzania, Mato and Kassenga (1997) uncovered that segregation of wastes takes place in only 56.5% of healthcare facilities. Similar observations have been made elsewhere. In a study conducted in 21 healthcare facilities in Northern Jordan for example, Abdulla *et al.* (2008) uncovered non-

segregation of chemical wastes in 76% of hospitals. Similar trends have been uncovered in Iran (Askarian *et al.,* 2004), Turkey (Alagoz *et al.,* 2008), India (Gupta & Boojh, 2003) and Brazil (Da Silva *et al.,* 2005). In areas where segregation is carried out at the source, mixing occurs at collection points (Oke, 2008). The environmental and human health risks associated with non-segregation of biomedical pollutants have been discussed extensively in the previous chapter.

4.7.2 Unsafe storage of biomedical pollutants

The most common process of storing wastes in households, industries, institutions and commercial establishments is by way of old buckets, woven baskets, pans and cardboard boxes. Such ineffective storage practices are applicable to biomedical wastes (BMW). In a healthcare facility in Ibadan, Nigeria, BMW is collected and stored at the point of generation in buckets, dustbins, pans and baskets prior to disposal (Coker *et al.,* 2009). A similar situation has been reported in Abuja, Nigeria where hospital staff reportedly store infectious and hazardous biomedical residue in old, uncovered buckets (Bassey *et al.,* 2006). Mato and Kassenga (1997) observed inappropriate storage of wastes such as, the use of paper boxes for storing sharp instruments including needles in Dar es Salam, Tanzania. In some instances, central storage units are unsanitary, unsecured and grants easy access to the general public as well as livestock. In a study undertaken in South Africa, Nemathaga *et al.* (2007) observed that waste storage facilities in some healthcare facilities did not have a locking system, making it accessible to unauthorized persons. Such ineffective waste storage practices pose major risks to public health.

4.7.3 Lack of Treatment

Added to the issue of unsafe storage practices is lack of treatment of biomedical pollutants. In a study conducted in Abuja, Nigeria, Bassey *et al.* (2006), observed the disposal of untreated BMW into open dumps and municipal sewers. In India, Gupta and Boojh (2008) also noted the disposal of unused blood specimens, sera and expired blood are washed down the drains after intermittent chemical disinfection. Similarly, Hassan *et al.*

(2008) had noted that in Dhaka Bangladesh, healthcare facilities discharge liquid pharmaceutical and chemical wastes into drains, sewers and lakes. A study by Al-Khatib *et al.* (2009) suggests that untreated dental solid wastes are disposed of in municipal dumps in Nablus district, Palestine. In Kano, Nigeria, Oke (2008) observed improper treatment of immunization wastes. Thus, despite its importance as a crucial process, waste treatment practices in many developing countries leaves much to be desired.

4.7.4 Open dumping and crude burning of biomedical pollutants

Open dumping and crude burning of biomedical pollutants have been reported in many developing countries (Kgathi & Balaane, 2001; Manga *et al.,* 2008; Nemathaga *et al.,* 2007). In parts of India for example, pathological wastes including amputated human body parts are mixed with regular waste and dumped in unsanitary landfills (Gupta & Boojh, 2008). Mato and Kaseva (1999) had also reported that more than 70 percent of healthcare facilities (HCFs) hospitals in Dar es Salaam, Tanzania practice onsite open dumping. Bassey *et al.,* (2006) observed an open dump situated adjacent to the main entrance of a healthcare facility in Abuja, Nigeria. In Botswana, crude burning is encouraged and promoted by community health workers as a viable alternative to incineration (Kgathi & Balaane, 2001). The environmental and human health risks associated with such dangerous practices have been discussed extensively in the previous chapter.

4.8 Underlying causes of the Problem

In this section, the underlying causes of the precarious waste management situation in developing countries are examined. Subsequently, the issues of governance, weak institutional capacities, corruption and political instability are discussed.

4.8.1 The Governance Perspective

One of the main issues underlying the waste management challenges facing developing countries is the issue of good governance. Most common definitions of good governance embrace the notion of a relationship between a range of actors within both civil

society and the state. Essentially, good governance involves citizen participation, transparency, equity, efficiency, openness, accountability and the rule of law[17] in planning and decision making processes (see for example, Bosselmann *et al.,* 2008; Izarabal 2005, p. 5). Citizen participation is vital for the harnessing of social capital and must aim at giving voice and representation to all groups and individuals to participate meaningfully in planning and decision making processes. Transparency as a sub-set of good governance is predicated on the free and unhindered flow of information as well accessibility to such information. On its part, the equity dimension is concerned with providing opportunities and granting access to all sections of the populations in the governance process. Likewise, the rule of law as a feature of good governance is rooted in the supremacy of the law and equality before the law. In other words, the rule of law in environmental governance is intended to ensure fairness and impartiality in both the planning and decision-making process. As stated by the UNDP, good governance must aim at providing citizens with the "rights, means and the capacity to participate in the decisions that affect their lives and to hold their governments accountable for what they do" (Bosselman *et al.,* 2008). Thus, good governance is a process rooted in the ideals of power sharing, flexibility, tolerance and respect for each other's views, especially that of local groups and communities (Nzomo, 1994; Owiti & Kibwana, 1994; Swilling, 1997:5; Young, 1996).

Despite the imperativeness of good governance to environmental management, the subject is often neglected in many developing countries. In some sub-Saharan African countries, ineffective governance has been shown to militate against the attainment of successful outcomes in waste management service delivery (see for example, Attahi, 1999; Kironde, 1999, Onibokun & Kumuyi, 1999; Swilling & Hutt, 1999). Many local populations are ignored in the environmental planning process and the decision making process is also devoid of any meaningful consideration of equity (see for example, Colby, 1990; Diaw *et al.*, 2002; Fekade 2000; Pery & Vanderklein, 1996; Pierre, 2000). A notable exception is Porto

[17] The rule of law as a feature of good governance is predicated on supremacy of the law and equality before the law

Alegre, the capital city of the Brazilian state of Rio Grande do Sul, where citizen participation constitutes an integral feature of the urban governance process (Bortoleto & Hanaki, 2007).

4.8.2 Weak Institutional Capacities

In addition to the problem of poor governance, public institutions in many developing countries also lack the capacities required for ensuring effective management of the environment. Chief amongst such weaknesses are fragmentation, ineffective legislative arrangements and resource constraints. In many developing countries in sub-Saharan Africa, waste and environmental management responsibilities are often devolved to multiple agencies without any clear means of monitoring and supervision (Kironde, 1999; Luduka, 1991; Manga *et al.*, 2008; Mwafongo, 1991; Onibokun & Kumuyi, 1999). Giving an account of the situation in Nigeria Onibokun and Kumuyi (1999: p. 88) noted that "the various agencies and institutions act in a fragmented manner and whenever they interact, they are likely to be on a collision course" (Ibid. 1999: p. 82.). This often results in conflicts, overlaps and duplication and subsequently, a loss of human and capital resources (Luduka, 1991; Manga *et al.*, 2008; Mwafongo, 1991; Onibokun & Kumuyi, 1999).

Additionally, many developing countries lack effective legislations for managing wastes and biomedical pollutants. Ayiniuola and Muibi (2008) noted that in Nigeria, inadequate policies and enabling legislation are at the core of ineffective waste management practices. Similar accounts have been reported in Botswana, South Africa, Turkey and India (see for example Berkun *et al.*, 2005; Kgathi & Balaane, 2001; Korfmacher 1997; Talyan *et al.*, 2008).

Furthermore, many developing countries lack the human, financial and technical resources necessary to ensure the effective management of waste. Financial resources are needed for the construction of sanitary landfills, proper incineration technologies, vehicles, equipment, recruitment, training and retaining qualified personnel. In the vast majority of developing countries however, the lack of funding constitutes a major problem that impacts waste management service delivery. Onibokun (1997) has noted in Nigeria: "lack of finance

turned many of the urban councils and municipal planning authorities into purposeless bodies and a drain on the regional/state governments". In Dar es Salaam, Tanzania, only 9% of the total funding requested by the city council in 1980 was granted by the central government (Kironde, 1999). It is unclear what the current situation. In Nigeria, Onibokun and Kumuyi (1999) indicate that poor financial conditions have rendered many local governments heavily indebted. The situation is compounded by out-dated and ineffective tax collection systems which make it difficult for local governments to mobilize revenue especially, within the informal sector (Bond, 1992; Hai, 1988; Mwafongo, 1991). The lack of financial resources at the household level also inhibits the ability of residents to pay for waste management services (Mwafongo, 1991; Werlin, 1995). Resultantly, some sections of the population resort to indiscriminate dumping and crude-burning practices, contributing to environmental degradation. In Lagos, Nigeria, Werlin (1995) noted that the inability of some residents in the Nigerian city of Lagos to afford waste storage bags contributes to indiscriminate dumping of wastes by roadsides. In an attempt to circumvent the issue of financial constraints, authorities in some developing countries have resorted to cost recovery measures in the form of user fees through systems such as pay-as-you-dump and a refuse levy (Attahi, 1999; Kironde, 1999; Onibokun & Kumuyi, 1999). However, such self-sustaining initiatives are yet to provide tangible results (Porter *et al.,* 1997).

Another major challenge confronting waste management institutions in developing countries is the lack of qualified personnel. This is due to the lack of financial resources needed to recruit and retain qualified personnel. In African countries in particular, the issue of lack of human resources has deep roots in the legacy of colonialism which allocated blue-collar jobs within the civil service to European colonialists and sanitation jobs to the indigenous population. This has left a major imprint in the psyche of many Africans who associate waste and environmental management with low socio-economic status. Therefore, many graduates are unwilling to study environmental issues due to the negative stigma associated with such jobs. Graduates who study such issues migrate to Western countries due to the lack of job opportunities, poor working conditions, lack of incentives and unattractive

remuneration. In 1995 for example, a World Bank study concluded that 23,000 highly skilled professionals migrate from the continent of Africa each year (Fadyomi, 1996).

In an attempt to address the issue of human resource constraints, decision-makers in many developing countries tend to rely on foreign experts and expatriates. This comes at a great cost for developing countries. According the World Bank, the cost of hiring 100 expatriates from advanced countries to work in Africa costs US$4 billion annually, representing close to 35% of official development assistance offered to the continent (Ibid. 1996). The reliance on foreign experts in environmental management in developing countries has several implications for environmental management. It may contribute to the development of policies and intervention strategies which are not congruent with the realities of the developing country in question. This is because most of these experts do not speak the language and are unfamiliar with the environmental practices of the indigenous population. Experts often rely on foreign planning and management concepts and theories which are wholly alien to the local polity. In addition, foreign experts use expensive tools and equipment which are beyond the reach of developing countries, creating a system of dependency. In many developing countries, capacity building has also evolved as a an approach to governance that seeks to strengthen, empower and equip institutions, individuals and communities with the tools necessary for advancing socio-economic, political and environmental justice (Eade, 1997; Farazmand, 2007). In particular, human capacity building entails “the process of equipping individuals with the understanding, skills and access to information, knowledge and training that enables them to perform effectively” (UNDP, 1992).

4.8.3 Corruption

Corruption is described in the literature as a highly prevalent practice in many developing countries (Khan, 1996; Mbaku, 2008; Theobald, 1997; Werlin, 1994). Corruption generally entails the diversion and abuse of public resources for private gains and takes the form of bribery, extortion, fraud, influence peddling and embezzlement (Rose-Ackerman, 1999; Werlin, 1994). The causes of corruption have been attributed to a multiplicity of

factors including inequality, poverty, culture, politics (Rose-Ackerman, 1999; Werlin, 1994). Two types of corruption are highlighted in the literature: individual and systemic. Individual corruption often takes the form of acts perpetuated by civil and public servants such as, the request for bribes in exchange of services rendered (Stapenhurst & Langseth, 1997). Systemic corruption refers to a situation where the act has become part of the fabric of a society or institution (Caiden & Caiden, 1994).

In the waste management discourse in many developing countries, the issue of corruption has been the subject of much discussion (Anku, 1997; Annor & Schweizer, 1996; Porter *et al.,* 1997; Post, 1999). A major reason accounting for the prevalence of corruption has been attributed to many factors including poverty and poor working conditions in the civil service. In addition, the public sector approach to service delivery is seen as an effective facilitator of corruption (Chapman, 1979; Hatry, 1983; Niskanen, 1971). Subsequently, privatization is touted as key to curbing corruption in public institutions (Adarkwa & Post, 2001; Obirih-Opareh, 2002). However, the effectiveness of the private sector in curbing corruption remains to be seen.

Corruption has several implications for waste management and the environment. It threatens the ideals of good governance by undermining market institutions and subverting policy reforms (Hope, 2000; Stapenhurst & Langseth, 1997). Corruption also contributes to environmental degradation and subsequently, retardation of national development due to the diversion of public funds for private purposes. This can contribute to violence, social disharmony and political instability (Klitgaard, 1997; Szeftel, 1998). Further, corruption has been used as an excuse for justifying military regimes in the political administration of many developing countries).

Despite several attempts to control corruption in public institutions in developing countries through greater accountability and transparency, the problems still persists (Rose-Ackerman, 1999; Szeftel, 1998). This underscores the complexity of addressing corruption. In many African countries for example, corruption is seen as conflicting with the traditional norm of gift giving. Similarly, many Muslims cultures consider the act of giving alms as

congruent with the teachings of Islam. Therefore, giving a gift to a public official may not be seen as an exception, but rather the norm.

4.8.4 Political Instability and Interference

The ability of any public institution to perform effectively is largely contingent upon effective political systems, stable regimes and the rule of law. This is a hallmark of good governance. In many developing countries however, frequent coup d'etats, civil wars and terrorist attacks render public institutions ineffective and unstable. For example, by the mid 1980's, 60% of African countries have experienced undemocratic military rule. In Ghana, there were five different military dictatorships from 1966 to 1981 (Keller, 1995). Similarly, in Nigeria, the Lagos Island Local Government worked under four state-federal administrations from January 1990 to May 1999 due to political instability (Onibokun & Kumuyi, 1999). The perception of a short and unstable tenure of office makes political and public officials prone to engaging in corrupt activities (Onibokun & Kumuyi, 1999). Such conditions have several implications for waste management and the environment. A sudden and unexpected change in any political process may also bring to a halt a particular environmental policy or program since new regimes are notorious for debunking and abandoning policies initiated by their predecessors. Such was the situation in Ghana during the First Republic when the military brass discontinued a sewerage system under construction in the Accra Metropolitan Area (AMA). Furthermore, new governments are also most likely to appoint supporters and cronies to senior positions, making decision making at the institutional level prone to political interference (Ali *et al.*, 1999; Bubba & Lumba, 1991). In some cases such political appointees may lack the relevant skills, expertise or qualifications to make effective decisions in their respective institutions.

4.9 Summary of Chapter

This chapter has provided an account of the management of wastes and biomedical pollutants in developing countries. The discussions in this chapter demonstrate a state of precariousness characterized by ineffective practices such as: inequitable service delivery,

infrequent collection, rudimentary storage, poor collection, unsafe transportation, crude burning and open dumping. The underlying causes of the problem are due to a myriad of complex factors including: poor governance, weak institutional capacities, corruption and political instability. The combinative effects of such factors contribute to ineffective management of wastes and biomedical pollutants which contributes to the elevation of risks to the environment and public health.

Chapter 5

Conceptual Analysis and Framework for Urban Management of the Environment (FUME)

5.1 Introduction

Waste pollution is primarily an environmental problem that often reverberates in adverse public health effects. In the environmental management discourse, several approaches have evolved over the years. This chapter reviews some major environmental planning and management frameworks with a view of identifying and selecting salient features for incorporation in the Framework for Urban Management of the Environment (FUME). The first part of the chapter examines concepts such as: the precautionary principle; the ecosystem approach; risk management; adaptive management; co-management and planning theory. The second part of the discussions presents the FUME concept and its various components.

5.2 The Precautionary Principle

The precautionary principle is a decision-making tool that implores stakeholders to implement effective management action to mitigate environmental and human health threats characterized by uncertainty (deFur & Kaszuba, 2002; Jordan, & O'Riordan, 1999; Raffensperger *et al.,* 2000). The most widely accepted definition of the precautionary principle states that "when an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically (Wingspread Statement, 1998: p. 2). Embedded in this core premise are a number of essential elements including: a duty and responsibility to act; shifting the burden of proof to proponents of an activity; considering of a wide range of alternatives when exploring management action for environmental problems and; public participation and transparency in the planning and decision-making process (*see*

for example, defur & Kaszuba, 2002; Jordan & O'Riordan, 1999; Kriebel *et al.,* 2001; McGarvin, 2003; O' Riordan & Stirling, 2001; Quijano, 2003; Rogers, 2001).

The precautionary principle is widely reported to have originated in Europe[18] in the 1970s in response to growing environmental problems. Since making its mark on the international stage, the precautionary principle has been adopted by a number of countries, institutions, agencies and organizations. In France, the precautionary principle is included in the constitution and mentioned in the country's Environmental Charter (Noiville, 2006). The precautionary principle has also been cited in a number of international agreements, protocols and frameworks including the Basel Convention (1992); North Sea Ministerial Declaration (1987); OSPAR Convention (1992); the Rio Declaration (1992); Protocol to the London Convention (1996); Convention on Biological Diversity (1992) and; the Bamako Convention on Hazardous Waste in Africa (1992) among others.

The growing interest in the precautionary principle has been attributed to a number of factors. Tickner (1997) for example, opines that the failures and limitations imposed by scientific certainty when identifying, understanding and mitigating environmental and human health risks accounts for the growing prominence of the precautionary principle. On their part, Kriebel *et al.* (2001) credits the rise of the precautionary principle to the slow pace of finding remedies to environmental problems such as climate change, ecosystem destruction and resource depletion. Raffensperger *et al.* (2000, p.1) also attributes the importance of the precautionary principle in terms of its ability to "engage the full resources of human intelligence in forming policies and practices that will protect the earth". Further, Smith (2000) believes the usefulness of the precautionary principle is due to its logical expression of commonsense concepts that guide daily life. Sayings such as, "*an ounce of prevention is worth a pound of cure*"; "*better safe than sorry*"; and the Hippocratic Oath's, "*first do no harm*" emphasizes the need to prevent harm before it occurs and can be seen as logical extensions of the precautionary principle (Ibid. 2000). Subsequently, Noiville *et al.* (2006)

[18] The origins of the precautionary principle have been traced to Sweden and Germany. In the German context, it originated out of the *Vorsorgeprinzip* meaning 'foresight' or fore-caring principle.

notes that had the precautionary principle been adopted earlier in France, loss of human lives and financial costs associated with exposure to asbestos may have been averted. Thus, deferring preventive measures until scientific evidence becomes available may produce catastrophic, costly and irreversible consequences (Tickner, 1997; Noiville *et al.*, 2006).

Conversely, critics of the precautionary principle have outlined a series of weaknesses associated with the concept. Some critics believe the implementation of pre-emptive management action can stifle scientific and technological innovation (Holm & Harris, 1999; Kriebel *et al.*, 2001; Santillo *et al.*, 1998; Sterling, 2000). This assertion has been debunked by proponents who argue that the validation of risks requires scientific knowledge which in some cases requires the use of technology (ILGRA, 2002; Noiville *et al.*, 2008). Therefore, the precautionary principle cannot be anti-science. Critics have also raised the possibility of abusing and misusing the precautionary principle for economic and political gains (Cooney, 2004; Lyons *et al.*, 2000; Raffensperger *et al.*, 2000; Saladin, 2000). Moreover, the precautionary principle can be used as a form of disguised protectionism by rich and powerful countries against poor developing countries. Other concerns such as equity, values, judgements and cost of applying the precautionary principle have been raised by critics (Cooney, 2004; Holm & Harris, 1999; Lyons *et al.*, 2000; Raffensperger *et al.*, 2000; Saladin, 2000).

5.3 The Ecosystem Approach

The ecosystem approach (see fig. 5.1) can be interpreted as a philosophy, methodology and strategy for understanding and solving complex environmental problems. Ultimately, the ecosystem approach aims at attaining equitable and sustainable outcomes in the management of air, land and water ecosystems and their living organisms through both scientific and non-scientific means (CBD, 2000; Lebel 1994; WHO & UNEP, 2008; Heissenbuttel, 1996; Szaro, 1998). The concept is widely believed to have originated in North America where it was used as a framework for managing the natural resources of the Great Lakes Basins (Caldwell, 1994; Lebel & Forget, 1994). Since then, the ecosystem approach has been ratified by 150 countries under the Convention on Biological Diversity

(CBD, 2000; Government of Canada, 2008; SER, 2008). Beattie (1996) provides a succinct summary of the ecosystem approach as follows:

> The underlying principle supporting this goal includes using an interdisciplinary, coordinated strategy to integrate the expertise and resources of all stakeholders; emphasizing damage prevention over mitigation or restoration; basing decisions on the best available science; recognizing that economic sustainability and societal well-being depend upon healthy ecosystems; recognizing that ecosystem processes must be addressed at varying scales; and being flexible and innovative.

Thus, the ecosystem approach aims at maintaining the health and vitality of ecosystems and humans while permitting some amount of risks in order for socio-economic needs to be attained (Brussard et al., 1998). It recognizes the role of humans both as central to the causes of problems facing ecosystems, as well as pivotal to solving such problems (Cooperrrider, 1996; Forget & Lebel, 2001). It is predicated on the notion that sustainability in any given society cannot be achieved without consideration of the larger ecological system of which society is a part (Waltner-Toews & Kay 2005).

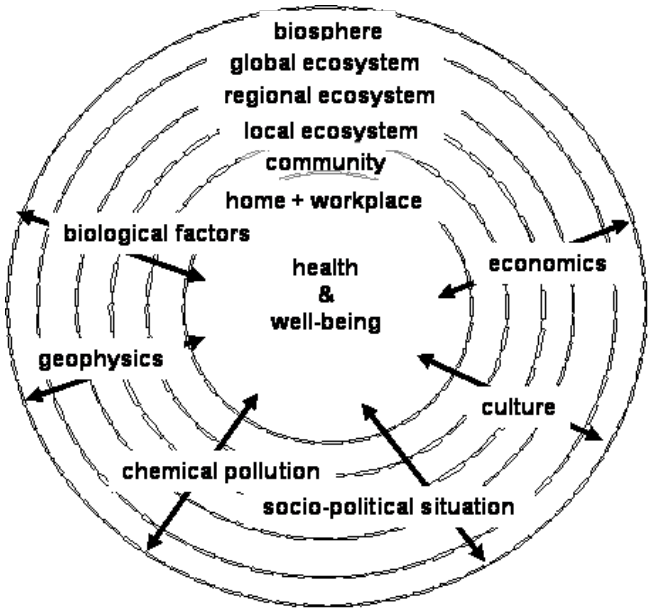

Figure 5.1: Framework for Ecosystem Approach

Adapted from EAHH, 2008

A central premise of the ecosystem approach involves the integration of scientific (systems-based) methods with collaborative processes in understanding and solving complex environmental problems (Lebel 1994; WHO & UNEP, 2008; Heissenbuttel, 1996; Szaro, 1998). Thus, the ecosystem approach can hardly be labelled as anti-science since it considers science as an integral part of a broader means of inquiry. In its scientific outlook, the ecosystem approach stresses a focus on the processes and functions of ecosystems while recognizing appropriate spatial and time scales (Brussard et al., 1998; Grumbine, 1994). The collaborative aspect of the ecosystem approach on the other hand implores planners and decision-makers to consider local and indigenous knowledge, values and experiences in the planning and decision-making process (CBD, 2000; Margerum, 1999; Margerum & Born, 1995; Szaro, 1998). Thus, it allows for the consideration of socio-economic as well as political factors when designing and selecting appropriate intervention strategies for environmental problems (WHO & UNEP, 2008; Heissenbuttel, 1996; Szaro, 1998). This approach underscores the role of humans and their institutions as central to both the causes of environmental problems as well as the solution (Cooperrrider, 1996; Forget & Lebel, 2001). The ecosystem approach further acknowledges uncertainties, changes and surprises that typically characterize environmental problems and stresses the implementation of flexible and adaptive management strategies (Christensen et al., 1996; Grumbine, 1994; Kessler et al., 1992). Table 5.1 below illustrates twelve basic principles of the ecosystem approach.

Table 5.1: Principles of the Ecosystem Approach

1	The objectives of management of land, water and living resources are a matter of societal choice.
2	Management should be decentralized to the lowest appropriate level
3	Ecosystem managers should consider the effects (actual or potential) of their activities on adjacent and other ecosystems
4	Recognizing potential gains from management, there is a need to understand the ecosystem in an economic context.
5	Conservation of ecosystem structure and functioning, in order to

	maintain ecosystem services must be a priority target of the ecosystem approach
6	Ecosystems must be managed within the limits of their functioning.
7	The ecosystem approach should be undertaken at the appropriate spatial and temporal scales.
8	Recognizing the varying temporal scales and lag effects that characterize ecosystem processes, objectives for ecosystem management should be set for the long term.
9	Management must recognize that change is inevitable.
10	The ecosystem approach should seek the appropriate balance between, and integration of, conservation and use of biological diversity.
11	The ecosystem approach should consider all forms of relevant information, including scientific and indigenous and local knowledge, innovations and practices.
12	The ecosystem approach must involve all relevant sectors of society and scientific disciplines

Adapted from UNESCO, 2000

Despite providing a logical framework for understanding and solving environmental problems, a successful implementation of an ecosystem approach can be impeded by a number of factors. The complex nature of ecosystems makes understanding of its structure, functions and processes a daunting, if not an impossible task (Brussard *et al*., 1998, Christensen et al., 1996; Kay & Schneider, 1994). The situation is exacerbated by resource and time constraints (Szaro, 1998). This can be a major problem for developing countries due to poverty and the lack of technical, human and financial resources. Jurisdictional issues and difficulties in coordinating across established political and institutional cultures may also pose a challenge for the successful implementation of the ecosystem approach (Caldwell, 1999; Gerlach & Berngston, 1994). Moreover, the diversity of human motivations may not augur well within interdisciplinary settings (Bell, 1994). Further, some critics label the ecosystem approach as a vague and narrow concept due to its broad and comprehensive disposition (Grumbine, 1994; Stanford & Poole, 1996; Slocombie, 1993).

5.4 Environmental Risk Management

Environmental risk management refers to the steps taken to control, prevent, reduce or eliminate the release of potentially harmful contaminants into ecosystems (Government of Canada, 2008). It involves a process of identifying, assessing, communicating and taking the best possible course of action regarding diminishing risks, using both scientific and non-scientific information (McColl, 2000; TBC, 2001). Most typical environmental risk management frameworks involve three main stages including risk analysis or assessment, risk communication and consultation with stakeholders.

5.4.1 Risk Assessment

Environmental risk assessment or analysis generally involves a process of determining the presence of contaminants in the environment through scientific and quantitative means (Lave, 1987; Wilson & Crouch, 1987). The process assists in measuring levels of acceptable harmful substances in the environment as well as the consequences of past exposures (Wilson & Crouch, 1987). Analysis of environmental risks typically assumes an ecological as well as human health dimensions. Ecological risk assessments address issues relating to the structure, functions and processes within ecosystems as well as the fate of ecosystem species. It aims at assessing the effects of contaminants on the food web, habitat and behaviour of living organisms within ecosystems (Chapman, 2002; Dobson, 1993; Purchase *et al.,* 1998; Suckling *et al.,* 1992). Human health risks assessment on the other hand, analyzes human health risks brought about by exposure to environmental contaminants (Kavlock *et al.,* 1996).

Risk assessment encompasses four main areas. These include *hazard/problem identification; dose-response relationship; exposure analysis* and *risk characterization* (Quijano, 2000; Russell & Gruber, 1987). *Hazard/Problem* identification determines whether available scientific information adequately addresses the causal relationship between a contaminant (for example, BMW residue) and an established impact on the environment or human health (Gosselin & Guidotti, 1999). This process is essential for setting planning and management goals (Patton *et al.,* 1993). *Dose–response* assessment addresses the

quantitative relationship between exposure and response in circumstances where adverse environmental and human health effects have been observed. Gosselin and Guidotti (1999) describe *exposure* assessment as a process whereby qualitative insight and quantitative data are sought on the degree, duration, frequency, sources and routes of exposure of contaminants into the environment. *Risk characterization* interprets the potential risk based on the relationship between exposure, dose-response and other relevant information (Quijano, 2000).

Although risk assessments cannot establish full scientific certainty, quantification can provide a basis for estimating the magnitude of an effect of exposure to contaminants (Russell & Gruber, 1987). An environmental risk assessment will also help to identify potential threats, set priorities and design suitable intervention strategies or provide a basis for further study (Lave, 1987; Russell & Gruber, 1987). Conversely, analyzing risks can be subjective and value laden and can contribute to polarization of views (Slovic, 2001). Experts and scientists can inject personal goals and interpretations during risk analysis (Lave, 1987). Further risk assessment can be a costly and time consuming process.

5.4.2 Risk Communication

The purpose of risk communication in environmental management is to disseminate information to relevant stakeholders with the objective of making informed decisions. Risk communication is therefore a vital component of environmental management and can determine the success or failure of policies and strategies (CSA, 1997; Slovic, 1993; Weterings & Eijndhoven, 1989). For risk communication to be feasible there is a need for communicators to understand societal perceptions, values and concerns regarding risk issues (Hance *et al*., 1989; Covello, 1989). A major way of achieving this goal is through two-way communication process where information, knowledge and experience are exchanged by all parties in order for informed decisions to be made (Leiss & Krewski, 1989). Essentially, two-way communication can build public trust in government and decision makers whereas one way (scientific and technical information from experts to the public) communication can generate misunderstanding, confusion, apathy and distrust (Covello, 1989; Jardin & Hrudey,

1997). It is also imperative that risk communicators are cognizant of the language used in risk communication since reliance on technical jargon and quantitative analysis may be confusing and rather exacerbate fears and raise suspicions (Covello, 1989; Jardin & Hrudey, 1997; Weterings & Van Eijndhoven, 1989). Further, risk communication must be facilitated in an atmosphere of honesty and transparency in order to quell scepticism and suspicion among the public (Hance *et al.*, 1989).

5.4.3 Consultation with Stakeholders

A common feature of most environmental risks is the role of humans. Consultation with stakeholders is a vital step in environmental risk management. Another component of most risk management frameworks involves consideration of socio-economic factors in formulating and choosing management approaches (CSA, 1997). At this stage, scientific information is not necessarily relegated to the background, but is integrated within an array of socio-economic factors in developing and choosing specific management strategies (CSA, 1997; Health Canada, 1993; NRC, 1983). Thus, environmental risk management involves a deliberate process of analysis, communication and consultation with different stakeholders on how best to control the release of harmful contaminants into the environment.

5.5 Co-Management Approach

The co-management approach involves a process of co-operation and partnership between central governments and local level stakeholders in the management of environmental resources. A fundamental premise underlying the co-management approach is the devolution of authority, one where central government authorities share responsibility for the environment with local communities (Persoon & Van Est, 1999; Misra & Kant, 2004; Timko & Satterfield, 2008). The co-management approach thus holds a pluralistic view of society, one where local solutions are sought for local problems and government intervention is solicited when necessary (Plummer & Fitzgibbon, 2004; Berkes, 2004). Effectively, the co-management approach advocates for fairness, transparency and equity in environmental

planning and decision-making by creating linkages between local and national level actors (Borrini-Feyerabend *et al.*, 2007; Fisher & Jackson, 1998; Kessler, 2003; Uphoff, 1998).

Proponents of the co-management approach tout several benefits associated with its use. These include an informed and democratic decision-making process, resolution of conflicts and stakeholder participation (Armitage *et al.*, 2007; Castro & Nielsen, 2001; Kothari, 2008). This can lead to increased efficiency and good governance of the environment (Armitage *et al.*, 2007). The process can also assist in the allocation of resources as well as the exchange and sharing of tasks, risks and power (Carlsson & Berkes, 2005). Further, a co-management approach can lead to the effective gathering and analysis of data (Pinkerton, 1989). Conversely, a number of questions have been raised about the efficacy of the co-management approach as a viable environmental management tool. Critics argue that stakeholder participation in environmental planning and decision-making may rather generate new conflicts or even aggravate existing tensions (Castro & Nielsen, 2001; Carlsson & Berkes, 2005; Jeffery & Vira, 2001). In some instances co-management strategies may rather reinforce and even intensify class and gender inequities within the community (Colchester, 2003). This is a real possibility in developing countries where ethnic, tribal, cultural and sectarian differences are rife. Some critics further charge the co-management approach as rich in rhetoric than in substance and lacks robustness (Hackel 1999; Polet, 2003; Roe *et al.*, 2000). Therefore, there is a need for further studies to determine its viability (Fisher & Jackson, 1998, p. 2). Other drawbacks such as the lack of operating resources, unstable political regimes and a host of entrenched socio-economic as well as political practices may militate against the effective implementation of co-management strategies. Subsequently, the ability of the co-management approach to yield successful outcomes has also been questioned by some critics (Algotsson, 2006; Hackel 1999; Polet, 2003; Roe *et al.*, 2000).

In summary, the rise of the co-management approach as an environmental management tool is predicated on the failure of the centralized and top-down approach in developing countries (Persoon & Van Est, 2003; Pomeroy, 1996).

5.6 Adaptive Management

The principle of adaptive management is predicated on the need to address the high degrees of uncertainty that typically characterize most urban environmental problems. The concept is widely believed to have evolved during the Gulf Island Recreation Land Simulation Study in the mid-1980s (Gunderson *et al.*, 1995). The principle of adaptive management operates on the premise that eradicating uncertainty in environmental problems is unfeasible (Holling, 1978. As such, the implementation of intervention strategies must be seen as experiments, leaving open the opportunity to accept, acknowledge and learn from mistakes (Briassoulis, 1989; Holling, 1978). This is due to the possibility of sudden changes in socio-economic, environmental, social and political systems. Subsequently, adaptive planning and management urges planners, decision-makers and all stakeholders to design and implement flexible management strategies that can be modified to accommodate sudden changes and surprises (Briassoulis, 1989; Holling, 1978; Marttunen & Vehanen, 2004). Public participation is deemed an essential component of adaptive planning and management (Lessard, 1998). This allows for the tapping of information from different stakeholders including scientists, planners, decision-makers and the general public when designing management strategies (Grayson *et al.*, 1994: p. 246; Holling, 1978: p. 8).

Advocates maintain that the greatest strength of adaptive planning and management lies in its ability to accommodate sudden changes and surprises. This may curtail the tendency to delay management action while research is conducted to reduce uncertainty (Harremoes *et al.*, 2002). The emphasis on public participation may also lead to transparency in the planning and decision-making process (Weterings & Eijndhoven, 1989). On the other hand, some critics argue that the idea of monitoring and making adjustments when new information becomes available can be expensive and expansive (Mitchell, 1997). This might constitute a problem for poor developing countries especially in instances where the nature of the problem supersedes resource availability. Adaptive planning and management also requires decision-makers to acknowledge mistakes, which they may not be willing to do

(Ibid. 1997). Furthermore, some critics argue that adaptive planning and management principles lack a clear means of implementation (Briassoulis, 1989; Lawrence, 2000).

In a nutshell, the principle of adaptive planning and management is fundamentally designed to accommodate uncertainty through the implementation of flexible management strategies to mitigate environmental risks.

5.7 Planning Theory

Planning, both as an academic discipline and a professional practice involves the application of foresight to the formulation and implementation of programs and policies deemed germane to the public interest (Faludi, 1973; Hudson, 1979). This includes the design of feasible intervention strategies for urban environmental problems such as, waste pollution. In pursuit of these objectives, urban planners are guided by a number of theoretical approaches including the rational comprehensive, incremental, transactive, advocacy and communicative planning models. In this section, an in-depth analysis of each of these different models is carried out with a view of identifying salient models for the FUME.

5.7.1 The Rational-Comprehensive Planning Model (RCP)

The rational-comprehensive planning model is considered the most dominant in the planning theoretical discourse and is widely believed to have evolved in response to problems caused by urban growth in Western societies in the 1960s (Briassoulis, 1989; Hudson, 1979; Mitchell, 1997). A cardinal feature of the RCP is a heavy reliance on scientific and quantitative methods to understanding and solving planning problems (Briassoulis, 1989; Hudson, 1979; Mitchell, 1997). Subsequently, the rational-comprehensive approach places power and trust in the hands of the planner who is seen as an expert with the key to an arsenal of information that can be tapped to address planning problems and issues (Alexander, 1986; Briassoulis, 1989; Hudson, 1979). Thus, the RCP takes an expert-driven approach to planning and decision-making.

In pursuit of its objectives, the RCP approach lays out a logical and deliberative framework for planning practice, marking one of its core strengths (Hudson, 1979). These include identifying a particular problem, setting goals, articulating aims and objectives, predicting and projecting outcomes, testing and implementing plans of action (Alexander 1986; Branch 1975). Theoretically, these could lead to the attainment of desirable outcomes in planning practice. In a practical sense however, the RCP has been critiqued as an inherently complex and unrealistic concept which has no real means of implementation (Alexander 1992; Arrow, 1958; Banfield, 1955; Campbell & Fainstein, 2003; Etzioni, 1967; Faludi; 1973; Forester 1989; Lindblom, 1959; Simon, 1976). This is because the deliberate framework laid out in the RCP approach requires an enormous amount of time and resources which may be limited. As well, its claim of objectivity due to reliance on quantitative and scientific methods has been debunked on the basis that biases can permeate planning processes resulting in individuals making decisions based on personal interests and agendas (Hudson, 1979:394). Further, the RCP model may impose subjective values in the planning and decision making process by acquiescing to the interests of the powerful while ignoring the needs of the weak (Campbell & Fainstein, 2003; Lindblom, 1959). A summary of the strengths and weaknesses of the rational-comprehensive planning model is illustrated in table 5.2.

Table 5.2: Summary of the strengths and weaknesses of the RCP model

Strengths	Weaknesses	Sources
Lays out a logical and deliberative framework for planning practice Considers a wide range of alternatives Problem identification Goal setting Articulation of aims and	Time consuming Complex and Complicated Reliance on scientific and Quantitative analysis Expert-driven and over-reliance on planner to provide solutions Lack of public consultation in	Alexander, 1986; Banfield, 1955; Brody, 2003; Dearden and Mitchell, 1998; Hodge, 1998; Hotovosky, 2006 O'Sullivan, 1981

objectives Prediction and projection of outcomes Testing and implementing of best plan of action	the process Unrealistic	

Although the RCP evolved in Western societies as a panacea to problems associated with urban growth, the approach has taken root in developing countries as the paradigm of choice and is the most utilized approach to waste management. Rondinelli (1993:92) attributes the failure of the RCP in developing countries to the displacement of political interaction and public participation from the planning and decision-making process.

5.7.2 The Incremental Planning Model

The incremental planning model evolved in the 1960's mainly in response to the dominance of the rational-comprehensive approach. Its chief exponent is Charles Lindblom, a political scientist who viewed the RCP model as an irrational process dominated by petty political concerns (Gunton 1984). Lindblom argues that for complex problems, the process of considering alternatives and setting goals is exhaustive, impossible and exceeds human abilities (Stiftel, 2000). Alternatively, decision-makers must simplify the planning process by selecting a small number of policy alternatives to be considered and evaluated (Etzioni 1967). This approach, proponents argue, will make the problem more manageable and allow for ongoing adjustments to be made during the process (Ibid. 1967). Incremental planning therefore requires planners to make micro plans with responsibilities devolved to multiple stakeholders through consultation and public participation (Friedmann, 1987; Hudson 1979). In this process, multiple stakeholders can form alliances to obtain support for their goals with the state acting as an independent mediator (Friedmann, 1987).

Proponents argue that one of the core strengths of the incremental model lies in its view of a pluralistic society where there are often divergent and competing interests.

Subsequently, the dynamic nature of planning and policy-making within the incremental model provides indemnity against those seeking radical changes (Forester 1987). By making decisions in incremental steps, there is also a lesser demand for information and this can lead to determinate solutions (Friedmann 1987). Conversely, critics contend that the idea of various groups, often with divergent views arriving at a common interest in a pluralistic society is questionable (Faludi, 1973). Such contentions are based on the rationale that society is dominated by certain groups and therefore incremental decisions favour those groups rather than the community in general (Etzioni 1967). Critics also argue that due to its limited consideration of variables, the incremental planning model lacks the tools necessary to guide the accumulation of small steps that are pertinent to bringing about significant change (Etzioni, 1967). A summary of the major strengths and weaknesses of the incremental planning model is highlighted in table 5.3.

Table 5.3: Summary of the strengths and weaknesses of the incremental planning model

Planning Model	Strengths	Weaknesses	Sources
Incremental Planning Model	-Breaks down environmental problems into manageable units -considers and evaluates a small number of policy alternatives -recognizes the pluralistic nature of society -Can be used for the attainment of short-term realistic goals	-Lacks the necessary tools needed for guiding the accumulation of small steps that are pertinent to bringing about significant change -Unable to cater for radical changes -May favour the dominant groups in society	Blum, 1974; Campbell and Fainstein, 1996; Etzioni 1967: 221; Faludi, 1973; 119 Friedmann, 1987; Lindblom, 1959; Mitchell, 1997; Stollman, 1988

5.7.3 The Transactive Planning Model

This transactive planning model is rooted in the premise of communicative rationality which fosters dialogue between planners and people affected by planning practice by taking a situation-specific, process-oriented approach. Essentially, the transactive model aims at providing an alternative to the centralized norms of planning practice by seeking diverse solutions at the local and regional levels of society (Friedmann, 1993; 79; Hudson, 1979:389; Mitchell, 1997:89). Such reasoning is based in the assumptions that there exists various interests in the society and all these interests have to be considered. Within the transactive model, populations assist in the planning through the contribution of socio-cultural, traditional beliefs and practices as well as experiences (Friedmann, 1993). Typically, the transactive planning model assumes five main dimensions including: normative, innovative, political, transactive and social learning (Friedmann, 1993). Table 5.4 outlines the five main dimensions of the transactive model.

Table 5.4: Main features of the transactive planning model. *Adapted from Friedmann, 1993*

Normative	the ideals of inclusive democracy; giving voice to the disempowered; integrating disempowered groups into the mainstream of economic and social life while preserving cultural diversity; privileging qualitative over quantitative growth, including the notion of sustainability; gender equality; and respect for the natural world" (77).
Innovative	Ascribes to "creative solutions to the social, physical and environmental problems that rise to political consciousness in the public domain" (78). requires planners to focus on current issues rather than finding solutions to future problems
Political	Planning should be political as a means of having the power needed to implement its goals (Ibid. 77).
Transactive	grounded in humanist vision need for some kind of negotiation between expert and experiential knowledge
Social Learning	Argues for an open process with two main characteristics: critical feedback and a strong institutional memory" (79).

As a planning theoretical concept, the transactive model has several advantages. The application of the transactive model can for example make the planning process more decentralized (Friedmann, 1993). Decentralization in the planning process may give voice to marginalized sections of the populations from the onset when planning problems are being identified (Ibid. 1993). This may strengthen communal responses and potentially lead to a sense of collective security (Ibid. 1993). Transactive planning may also bring more detailed and specific knowledge to bear on a situation than would be possible if only expert knowledge were used (Ibid. 1993).

In spite of the perceived strengths of the transactive model, critics have laid out a number of shortcomings associated with the model. One major critique of the transactive model is that including others in the planning process may impose a pressure of time and resource constraints which may be elusive to a large number of the populations especially, the economically deprived (Friedmann, 1993). This may lead to neglect of the interests of marginalized people and their communities in the planning process. A summary of the major strengths and weaknesses of the transactive model is depicted in table 5.5.

Table 5.5: A summary of the strengths and weaknesses of the transactive planning model

Strengths	Weaknesses	Sources
-Encourages face to face interaction and dialogue with stakeholders -May contribute to a mutual learning process -A decentralized approach to planning - May bring more detailed and specific knowledge to bear on a situation than would be possible if only expert knowledge were used -May strengthen communal responses and can potentially lead to a sense of collective security	-May impose a pressure of time constraints which may be elusive to a large number of the population especially, the economically deprived - May contribute to the neglect of the interests of such marginalized sections of the population in the planning process -Can be costly and expensive	Friedmann, 1973; Mitchell, 1997

5.7.4 The Advocacy Planning Model

The advocacy planning model is believed to have evolved in the United States as a response to growing discontent with the exclusion and marginalization of poor people and minorities in the planning process (Checkoway, 1994; Clavel 1994). This model views the dominant framework for planning practice as an affront to pluralism and therefore, charges planners to democratize the process as a way of dealing with inequalities and bringing marginalized groups into the process (Checkoway, 1994; Davidoff 1965; Howe, 1979). One of the chief proponents of this model is Paul Davidoff, an American planning practitioner and a lawyer. He argued:

> *the recommendation that city planners represent and plead the plans of many interest groups is founded upon the need to establish an effective urban democracy, one in which citizens may be able to play an important role in the process of deciding public policy"* (Davidoff, 1965: 211).

The advocacy model therefore rejects the notion of a general public interest as the basis for planning practice since this only goes to enhance the fortunes of the privileged and the influential in society (Peattie, 1968). Rather, the need for planners to recognize the multiplicity and diversity of society with opposing goals and interests is paramount (Clavel, 1994; Davidoff, 1965; Peattie 1968; Howe, 1979). Effectively therefore, advocacy planning practitioners strive to immerse themselves in the political process and act as advocates for governments, groups, individuals and organizations who have a stake in the planning outcome (Davidoff 1965). Proponents argue this process will facilitate the democratization, inclusion and empowerment of marginalized stakeholders in the planning process (Davidoff, 1965; Harwood, 2003). Potentially, this can assist to raise awareness about a particular situation and exert pressure on different levels of government to act on the issue (Harwood, 2003). Ultimately, advocacy planning can contribute to the development of infrastructure in marginalized communities (Clavel, 1994; Harwood, 2003; Krumholz & Forrester, 1990; Needleman & Needleman, 1974). In spite of its good intentions, a number of weaknesses have been linked with the advocacy planning model. Forrester (1994) for example opines that

advocacy planning requires practitioners to work in the reality of contentious meetings "where substance competes with exaggeration, where respect competes with racism, where trust competes with accusation, where careful listening competes with irate presumption". Advocacy planning can also create a culture of dependence where affected communities will rely on planners to effect change (Harwood, 2003; Peattie, 1968; Piven, 1970). Furthermore, the advocacy model has been critiqued as a one-sided model which does well in the process of planning but falters in the competition of plans (Marris, 1994). Table 5.6 adumbrates the strengths and weaknesses of the advocacy planning.

Table 5.6: A summary of the strengths and weaknesses of the advocacy planning model

Strengths	Weaknesses	Sources
-Inclusion and empowerment of marginalized and often neglected residents in both the democratic and planning process -Potential to raise awareness about a particular situation -May exert pressure on different levels of government to act on environmental issues	-May do well for planning process but lacks a competitive edge -Ability to effect meaningful change has been questioned -The process may be tedious and counterproductive -Tends to be one dimensional -Planner cannot be neutral	Clavel, 1994; Checkoway, 1994; Davidoff, 1965; Harwood, 2003; Krumholz & Forrester, 1990; Forrester, 1994; Howe, 1979; Marris, 1994; Needleman & Needleman, 1974; Harwood, 2003; Peattie, 1968; Piven, 1970;

5.7.5 The Communicative Planning Model (CPM)

The communicative planning model (CPM) is predicated in the need for communication, consensus-building, negotiation and conflict resolution in the planning process (Friedmann, 1998; Healey, 1997; Innes, 1995; Taylor, 1998). This approach involves a process of "practical deliberation involving dialogue, debate and negotiation among planners, politicians, developers and the public" (Taylor, 1998: 71). Essentially, the CPM places practitioners in the role of experiential learners vested with the responsibility of

ensuring agreement among multiple stakeholders (Healey 1996). The objective is to ensure that whatever the position of participants within the social economic hierarchy, no group's interest will dominate (Ibid. 1996:176). This ensures the consideration of the views, values, knowledge and experience of local stakeholders in the planning process (Mitchell, 1997). Ultimately this can give local stakeholders a sense of ownership over the outcomes of planning decisions. Additionally, effective dialogue within the communicative planning process will facilitate agreements and consensus in an atmosphere of mutuality which can contribute to personal growth among stakeholders (Innes & Booher, 1999; Healey, 1997; Sager 1994; Buchy & Race, 2001). On the other hand, critics contend that the implementation of communicative planning can be mired by participants' values, interests and attitudes (Moote *et al.*, 1997; Paulson, 1998; Kellert *et al.*, 2000; McGuirk, 2001; Parkins, 2002; Bradshaw, 2003). This can result in conflicts especially if participants are unable to reach agreements favourable to their interests (Moote *et al.*, 1997; Hooper *et al.*, 1999). The communicative planning process can also be hijacked by the elite and powerful in society, thereby eroding the very essence of its collaborative ideals (Friedmann, 1987; Healey, 1997). The notion of forging consensus in a heterogeneous and schismatic environment is also being questioned by some critics (Brand & Gaffikin, 2007). A summary of the major strengths and weaknesses of the communicative model is illustrated in table 5.7.

Table 5.7: A summary of the strengths and weaknesses of the communicative planning model

Strengths	Weaknesses	Sources
-Provides a forum for the inclusion of indigenous views -Views society as a pluralistic entity -Provides opportunities for lay people to have a sense of ownership of a planning outcome	-May be time consuming -May not ensure environmental quality -Participants may bring subjective interests to bear on the process -May contribute to conflicts and disharmony	Arnstein, 1969; Booher, 1999; Bradshaw, 2003; Brand & Gaffikin 2007; Buchy & Race, 2001; Friedmann, 1987; Healey, 1997; Innes, 1995; Innes & Sager 1994; Kellert et al., 2000; McGuirk, 2001; Mitchell, 1997; Moote et al., 1997; Parkins, 2002; Paulson, 1998; Taylor, 1998: 71

5.8 Conceptual Gaps

Evidently, the various approaches to environmental governance can be said to address some aspects of the problem while neglecting other dimensions, the extents of which are outlined in table 8.1.

Table 5.8. Gaps in Current Environmental Planning and Management Approaches

Environmental Management Concept	Deals with uncertainty	Public participation & stakeholder consultation	Economic considerations/ resource constraints	Equity
Precautionary Principle	Yes	Yes	No	No
Ecosystem Approach	No[19]	Yes	Yes	Yes
Environmental Risk Management	No	Yes	No	No
Adaptive Management	Yes	Yes	No	No
Rational Comprehensive Planning	No	No	No	No
Incremental Planning	No	Yes	No	No
Transactive Planning	No	Yes	No	Yes
Advocacy Planning	No	Yes	No	Yes
Communicative Planning	No	Yes	No	No

In chapter 4 of this thesis, it was deduced that the underlying causes of the waste management challenges facing developing countries are attributable to various factors including ineffective governance, weak institutional capacities, corruption, political

[19] The ecosystem approach does not address uncertainty in the same manner as the precautionary principle.

instability and resource constraints. In this regard, any attempt to effectively address the situation must be cognizant of the need to address all the different facets of the problem. Based on the analysis in the previous section however, it is unclear how any one of the environmental planning and management approaches addresses the diversity of waste management challenges facing developing countries. For instance, as an environmental planning and management framework, the precautionary principle emphasizes the need to address uncertainty and public participation but do not provide any tangible means of addressing resource constraints. On its part, the ecosystem approach accentuates the need to understand ecosystems from an economic perspective but does not address uncertainty in any meaningful manner. In fact, only the precautionary principle and adaptive management addresses uncertainty and only the ecosystem approach addresses economic considerations in environmental management.

The gaps in current environmental management frameworks can be said to be a major contributing factor to the state of precariousness surrounding the management of urban wastes in developing countries. Therefore, the need for a framework that addresses the diversity of waste management challenges is warranted. It is in this light that the Framework for Urban Management of the Environment (FUME) is proposed in this thesis as a suitable alternative to understanding and addressing waste management challenges in a developing country setting.

5.9 Addressing Conceptual Gaps: An Eclectic Framework for Urban Management of the Environment (FUME)

The FUME model has been designed to provide a refreshing way of thinking, planning, acting, implementing, evaluating and monitoring waste management strategies in a developing country setting. The model is constituted of salient features of the precautionary principle, ecosystem approach, environmental risk management, co-management, adaptive management and integrated waste management. Therefore, the FUME model does not reject or negate the usefulness of existing environmental planning and management concepts but

rather, selects suitable intervention strategies that reflect the realities of the situation. A conceptual representation of the FUME model is presented in figure 8.2.

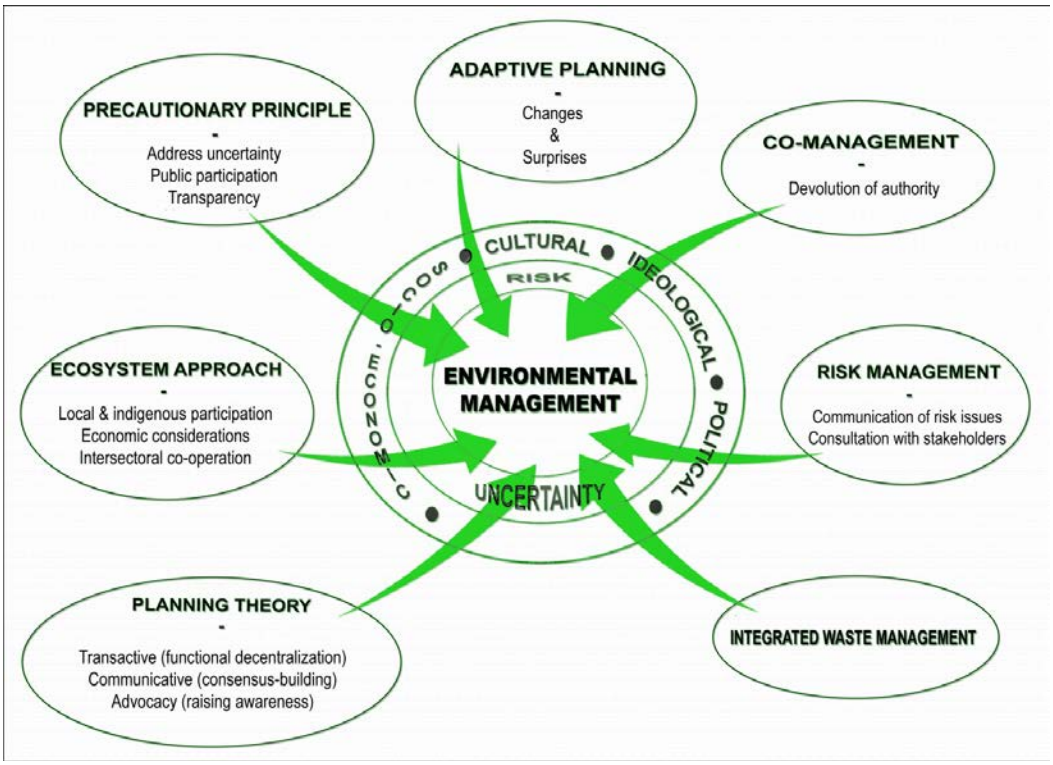

Figure 8.1: Conceptual Representation of the Framework for Urban Management of the Environment (FUME). *Developed by Squire, 2010*

As illustrated in the above diagram, the FUME model recognizes that most environmental problems are characterized by high degrees of uncertainty. Further complexity arises out of a myriad of a myriad of socio-cultural, economic, ideological and political factors. Therefore, understanding and addressing environmental problems require a framework that permeates risks, uncertainty as well as underlying complexities. As a codicil to the FUME model, the precautionary principle places emphasis on addressing uncertainty, public participation and transparency. This is considered a germane approach to dealing with waste management challenges in a developing country setting. Among the various principles underlying the ecosystem approach, the call for the consideration of indigenous views in

environmental planning and management processes, intersectoral co-operation, as well as the consideration of the economic benefits of healthy ecosystems is deemed worthy of incorporation into the FUME model.

Within the vast field of planning theory, the communicative, transactive and advocacy models are deemed salient to the objectives of FUME. The purpose of communicative planning is to provide a forum where the planner provides valuable information which may be scientific, while listening to grievances held by other stakeholders. This approach circumvents the top-down approach which is dominant in developing countries. Similarly, the emphasis on functional decentralization within the transactive model is meant to encourage grassroots participation in planning and decision-making processes. This approach offers a digression from the centralized approach to planning and decision-making that characterizes environmental governance in many developing countries. The advocacy planning model is seen as an important tool for raising awareness about environmental issues with the aim of encouraging and promoting behavioural changes.

Devolution of authority as engrained in the co-management approach does not imply a complete ceding of power by governments but rather, a necessary tool for effective collaboration between all actors within the realms of public, private and civil society. For instance, in cases where the nature of the problem requires resources beyond the reach of local stakeholders, governments at all levels might step in and take a leading role since they have resources that are not available to non-governmental actors. Similarly, environmental risk management is seen as providing a forum where risk issues can be communicated to stakeholders in a two-way process. On its part, the purpose of adaptive management within the FUME model is to provide a platform for accommodating sudden changes and surprises in ecosystem structure, functions and processes. Adaptive management also provides a cushion against socio-economic and political uncertainty. Finally, the purpose of the integrated waste management component is to provide a basis for the selection suitable techniques for the management of different types of waste in consideration of their socio-economic and political impacts.

5.10 Summary of Chapter

This chapter has provided a conceptual analysis of some of the main approaches to environmental management. The chapter also discussed the FUME concept and its different components. The analyses demonstrate that the FUME model applies complex systems thinking, knowledge and innovation systems to understanding and solving environmental problems. Its emphasis on public participation, stakeholder consultation, adaptive management, economic considerations, co-management, risk communication, functional decentralization, consensus building, transparency and awareness-raising are deemed particularly useful to the attainment of successful outcomes in understanding and solving complex environmental problems such as, waste management. Although the FUME model is developed with the intention of ameliorating waste management conditions specifically in developing countries, it is capable of modification and application toward other environmental problems. However, in order for the FUME to be effective, it is imperative that stakeholders adapt its implementation to local conditions and realities.

Chapter 6

Case Study: Epistemology, Design and Methodology

6.1 Introduction

This chapter discusses the underlying epistemology, methodology and design of the case study component of this research. In section 6.2, post-positivism is highlighted as the underlying epistemology that informs this research. Section 6.3 discusses the approaches to data collection including survey questionnaires, interviews, informal group discussions and observation techniques. Approaches to the collection of secondary data are presented in section 6.5. This is followed by a discussion of the data management and analytical techniques in section 6.6. A discussion of the study limitations and challenges is the focus of attention in section 6.7, followed by a summary of the chapter in section 6.8.

6.2 Post-Positivist Epistemology

Post-positivism epistemology assumes a metatheoretical position that emphasizes social construction of theories and concepts by using primarily qualitative approaches toward the discovery of multiple realities and knowledge (Yolles, 2006). It evolved in response to the dominance of positivism which is predicated in the use of quantitative means to discover a single reality (Guba & Lincoln, 1996). Several reasons account for the choice of post-positivism as the primary epistemology that informs the case study component of this research. Chief amongst such reasons is the need to ensure objectivity and validity of the research process. As discussed in chapters 2 and 3, ineffective management of waste including biomedical pollutants contributes to a host of risks to the environment and human health. However, a paucity of information regarding cause and effect relationships contributes to high degrees of uncertainty. In addition, a plethora of complex socio-economic and political factors militates against the attainment of effective outcomes in regards to waste management service delivery. These include ineffective governance, corruption, political instability and poverty. Therefore, the waste management situation in developing countries

cannot be understood from a positivist viewpoint which is predicated in the existence of a single reality. Positivists may for example view the risks posed by biomedical pollutants to the environment and human health as probabilities and consequences of adverse events be produced by physical and natural processes in ways that can be objectively quantified by risk assessment (Slovic, 1999). Yet, subjectivity can permeate the risk assessment process due to the dependence on human judgments at every stage of the process, from the problem identification stage to the estimation of exposures (Slovic, 1999; Wilson & Crouch, 1987). In contrast, post-positivists argue that risks are socially constructed, perceived subjectively and therefore lacks objectivity (Beck, 1992; Covello, 1989; Slovic, 2001). Therefore, the post-positivist epistemology allows researchers to understand the existence of multiple realities and the possibility of injecting axiological subjectivity in the research process.

Another reason for the choice of post-positivist epistemology is rooted in the need to obtain a first-hand account of the research phenomenon. Ineffective management of waste, including biomedical pollutants occur as a result of human actions or inactions for that matter. Understanding and addressing the situation therefore require a process of immersion into the terrain and interaction with the very people whose lives are likely to be impacted by the outcome of the research. Within the positivist domain however, this position is risky and unacceptable. Positivists argue that objectivity requires researchers to maintain a social and professional distance from the research phenomenon (Acker *et al.*, 1991, p. 139; Palys, 1997; Morgan & Smirch, 1980). This is based in an assumption that holds that "the closer one comes to dealing with people on a one-on-one basis, the more dangerous the situation becomes, since one might be tempted to resort to metaphysical concepts such as thoughts, perceptions, attitudes and values" (Palys, 1997, p. 14). Effectively, the positivist epistemology posits researchers as experts who are fundamentally responsible for formulating, testing and manipulating theory to attain validity. Positivist epistemologists further argue that the flexibility offered by post-positivism might render research findings inconsistent and unreliable (Cassel & Symon, 1994).

Such positivist assumptions are considered fundamentally flawed and therefore antithetical to the overall objectives of this research. By placing the researcher in the position of an expert, there is a risk of injecting subjectivity in the findings. Researchers are human beings with their own personal opinions, beliefs and values which can influence the research process. Consequently, findings presented as objective truths may actually turn out to be the beliefs, analyses and interpretation of the researcher. The positivist epistemology fails to acknowledge this basic fact. Moreover, by maintaining social and professional distance from the research participants or phenomenon, there is a risk of alienating and marginalizing the very people whose lives are likely to be affected by the outcome. This may foster a relationship of distrust between the between the researcher and research participants, contributing to a general feeling of apathy on the part of participants. Such conditions have a high proclivity to contribute to the collection of skewed data garnered through distorted information. Passing on such data as objective truth may have some serious consequences for the group, people or phenomenon studied. The failure of the top-down and expert-driven approaches to environmental governance in developing countries is a likely repercussion of the positivist epistemology.

Essentially therefore, the post-positivist notion of creating and sustaining social reality through the direct experience of people involved in the research (Morgan, 1980; Denzin & Lincoln, 1994; Key, 1997) is deemed germane to the objectives of this study. For post-positivists, intimacy enables researchers to interact with research subjects in their own setting and on their own terms while understanding their roles, values, bias and subjectivity in the inquiry process (Kirk & Miller, 1986; Palys, 1997). Ultimately, this would ensure validity and also contribute to the gaining of broader insights and perspectives into the phenomenon under investigation (Bogdan & Taylor, 1975). Thus, the post-positivist epistemology provides the dynamism required for understanding and solving complex environmental problems in a developing country context.

6.3 Research Design

This research has been designed as a post-positivist, interpretivist and exploratory single case study. This approach entails the investigation of a social phenomenon in its natural setting using multiple sources of evidence and post-positivism allow for the fusion of both qualitative and quantitative methods in the inquiry process (Babbie, 1989; Borse, 2004; Creswell *et al.*, 2003; Johnson & Onwuegbuezie, 2004; Yin, 1984). This approach has been credited for bringing flexibility and simplicity to the research process and was utilized during the field investigation. In particular, triangulation provides a forum for understanding a research problem, identifying variables and cross-checking information (Marten, 2003; Punch, 1998). This is known to improve credibility, dependability and objectivity of the research findings (Yin, 1993; Decrop, 1999). This position implies that post-positivist does not totally reject positivism but rather, strives toward epistemological and methodological equilibrium.

Prior to undertaking the case study from January to March 2010, a stratified random sampling profile was created for the purpose of identifying major stakeholders. Subsequently, key informants comprising of healthcare providers, waste management service providers, urban authorities and central government officials were identified and solicited for information. An attempt was made to identify and include environmental non-governmental organizations with interests in waste pollution but this did not materialize due to the fact that most of these organizations were found to exist only in paper. The various stakeholders identified were solicited to participate in the research via telephone conversations as well as through local contacts. The objective of using local contacts to solicit interview requests was to save time. Prior to the commencement of the case study research, ethics clearance was obtained from the Office of Research Ethics at the University of Waterloo. The approval process involved an extensive review of the research proposal including the interview questions. Thus, the research was carried out in conformity with the standards of the University of Waterloo's Office of Human Research Guidelines for Research with Human

Participants. Such standards include honesty of conduct, protection of confidentiality and anonymity, the use of informed consent and the principle of reciprocity.

6.4 Data Collection

A variety of data collection methods were employed during the case study in Accra. These include survey questionnaires, interviews, group discussions, site observation and photographic documentation. However, due to conditions of confidentiality and anonymity, none of the individuals, institutions and facilities sampled and surveyed is directly identified in this study. Pseudonyms in the form of interviewee and facility numbers are used as a way of concealing the identities of individuals involved in the research as well as facilities surveyed as part of the observation process. A list of the numbers used for identifying individual interviewees is presented in table 6.1.

6.4.1 Survey Questionnaires

As part of the field investigation process, a survey questionnaire[20] was developed and distributed in the AMA with the objective of ascertaining the views of residents in regards to the general waste management situation in the metropolis. Palys & Atchinson, (2008) had noted that survey questionnaires are relatively cheap, easy to analyze and can generate a substantial amount of data quickly. In line with this rationale, a total of 750 questionnaires were distributes through a selective sampling process of which 380 responses was garnered indicating a less that 40% response rate. Two research assistants were employed to deliver the survey questionnaires at various workplaces throughout the AMA. Although this approach is selective, it was meant to ensure random outcomes in the sense that the responses touched on the general issues of waste management of which every respondent is assumed to have a fair amount of familiarity. The objective was to ascertain to a minimal extent, the views of ordinary citizens regarding the waste situation. The selective sampling process also explains why a high number of respondents had university education. The research assistants

[20] See appendix A

were adequately briefed as to the nature of the investigation by the researcher prior to the commencement of the research. In most cases, the questionnaires were left with respondents for a couple of days and collected by the research assistants usually at the end of the week. Of total number of responses 65% (247/380) identified as females and 35% (133/380) identified as males. Overall, 20% (76/380) of respondents fell between the 18-29 age group, 60% (228/380) were between the ages of 30-49, while another 20% (76/380) were 50 years of age and over. In terms of the educational backgrounds of respondents, 25% (95/380) had secondary level education, 15% (57/380) had vocational-technical education, 20% (76/380) had polytechnic education, and 55% (209/380) had university education. A breakdown of the age distribution and educational backgrounds of survey respondents are presented in figures 6.1 and 6.2. None of the survey respondents received any honorarium for their participation in the study.

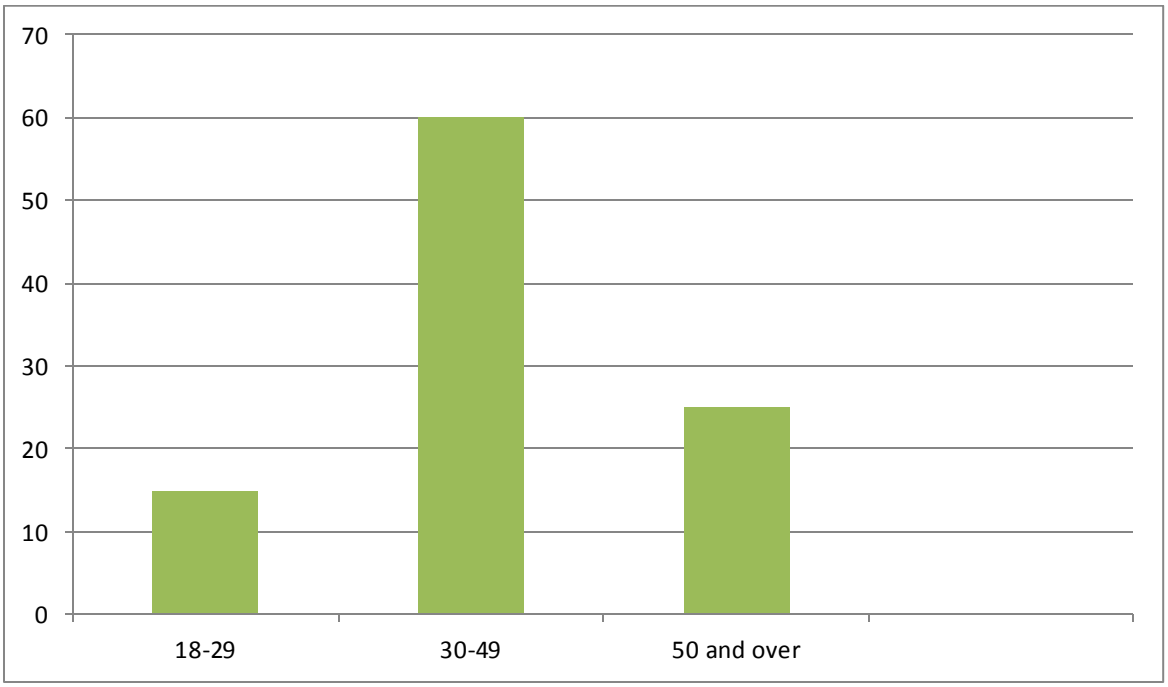

Figure 6.1: Age distribution of survey respondents in %

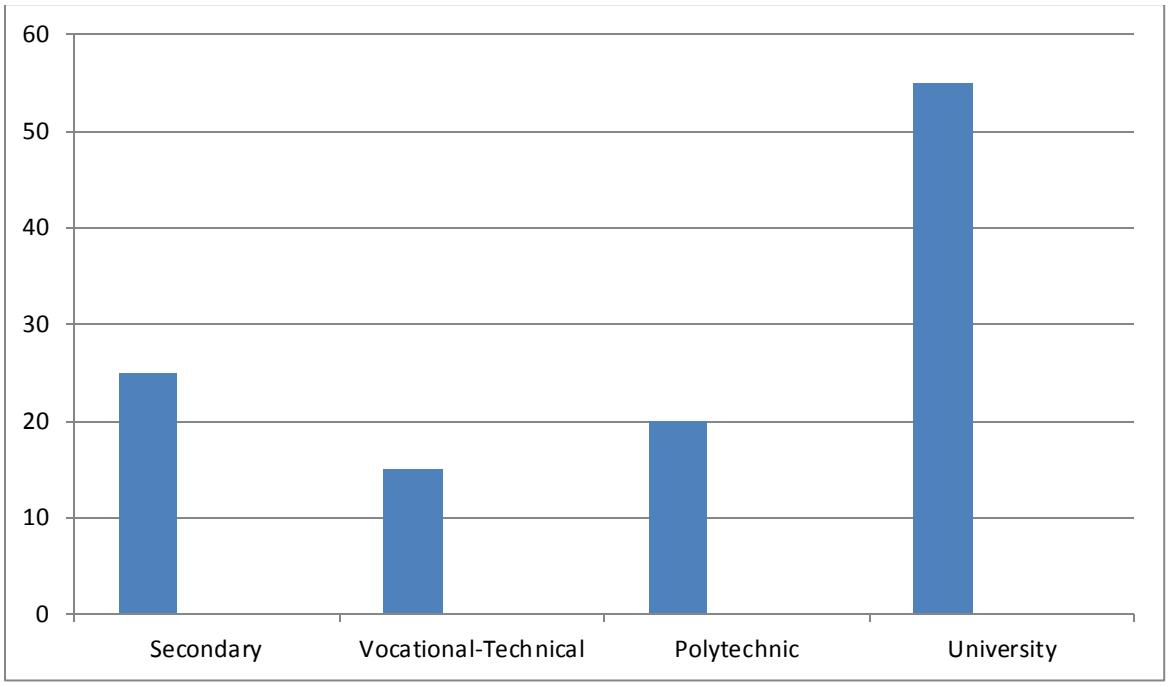

Figure 6.2: Educational background of survey respondents in %

6.4.2 Interviews

Interviewing as a data collection technique in post-positive research is a fairly common practice and involves the preparation of a guide that lists a predetermined set of questions for the purpose of eliciting information from participants (Rogers & Bouey, 1996). During the field investigation 25 key informants[21] were interviewed[22] in a semi-structured format. The semi-structured format provided a great amount of flexibility and allowed new questions and insights to be included during the course of the interviews. The interviewees were identified and selected through purposive sampling based on their familiarity with the subject matter. The interview questions were both specific and open-ended and focused on major issues pertaining to the phenomenon under investigation. Specific interview guides were developed for each of the different stakeholder groups including healthcare providers,

[21] See appendix D for the list of interviewees
[22] See appendix B.1 for the list of interview questions and guides

waste management service providers, local and central government officials. The objectives of the interviews were to collect data in the following areas:

- The state of waste management in the AMA
- The management of biomedical pollutants in healthcare facilities as well as at the systemic level
- The general waste management structure in the AMA
- Potential risk factors related to the management of wastes and biomedical pollutants
- Plans for improving the current waste management situation in the AMA
- The challenges and successes of existing waste management programs
- The views of interviewees regarding intervention strategies outlined in the literature

All of the interviews were conducted at the offices of interviewees except on three occasions when interviewees requested to be interviewed at their private residences. The interviews were conducted in English and each lasted an average of 50 minutes. An audio recorder was used to record most of the interviews, and notes were also taken as a back-up. Some interviewees objected to being recorded out of fear of reprisals by superiors. This request was adhered to by the researcher and detailed handwritten notes were taken instead. Due to conditions of confidentiality, the names, positions and duty stations of interviewees is not disclosed in this thesis.

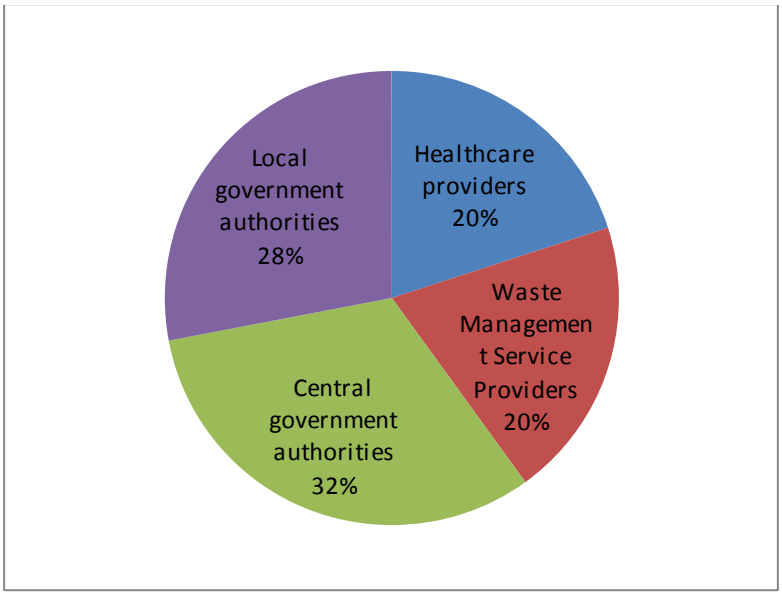

Figure 6.3: Percentages of Professional affiliation of interviewees

Interviewees were asked to share their opinion regarding the management of wastes including biomedical pollutants in the AMA. Interviewees were also requested to provide input on management strategies drawn from various environmental planning and decision-making tools, concepts and theories. The semi-structured format provided a great amount of flexibility and allowed new questions and insights to be included during the course of the interviews.

6.4.3 Informal Group Discussions

In line with the objective of considering the views of all stakeholders[23] during the research process, two separate informal focus-group discussions were carried out as a data collection mechanism. The informal sessions were interactive forums in which the views, opinions and perspectives of junior level healthcare providers, sanitation staff and waste management service providers were solicited. Participants were invited through oral requests. The meetings were held at a mutually agreed upon location and was facilitated with the help

[23] Frontline and backend staff of healthcare facilities, waste management service providers, local and central government officials as well as members of the general public.

of two research assistants. Due to fear of retribution, participants requested that the meeting not be audio or video recorded. This request was adhered to. However, hand written notes were taken during the discussion. The discussions were conducted in English as well as two local dialects, Ga and Twi. The researcher is fluent in all three languages.

6.4.4 Site and Participant Observation

Observation as a post-positivist data collection method is generally defined as the process of immersing oneself in an environment or way of life in order to gain knowledge, and understanding of an issue or phenomenon (Bogdan & Taylor, 1975). The observation approach had been labeled as one of the most intimate forms of social research which allows researchers to be actively involved in the environment where the research is carried out (Lofland, 1972). According to Key (1997) there are five main types of observation. These include: external participation, passive participation, balanced participation, active participation and total participation. In the context of the current study, a balanced-participant observation approach was adopted. A balanced-participation observation approach typically involves the researcher maintaining a balance between being an insider coming from outside to investigate a phenomenon (Key, 1997). This approach can lead to the unintentional discovery of relevant data during the research process (Hornsby-Smith, 1993). For instance, during one of the observation processes, it was uncovered that plastic wastes constitute one of the most widely generated types of waste in the AMA. Patton (1990) also notes that observation in post-positivist research may enable the researcher to witness events that participants are not aware of, or may be reluctant to discuss in interviews.

Subsequently, numerous visits were made to a number of healthcare facilities and waste disposal dumps in the AMA. A list of the healthcare facilities visited during the observation process is listed in table 6.2. Photographs were taken during the site observation as a way of shedding light on the situation. Much care was taken not to photograph individuals or private structures without their approval or consent.

Table 6.2: Types and affiliation of facilities surveyed in the AMA

Facility #	Facility Type	Affiliation
1	Healthcare Provider	Private
2	Healthcare Provider	Government
3	Healthcare Provider	Private
4	Healthcare Provider	Government
5	Healthcare Provider	Private
6	Healthcare Provider	Government
7	Healthcare Provider	Private
8	Healthcare Provider	Government
9	Healthcare Provider	Private
10	Healthcare Provider	Government

6.5 Secondary Data Collection

Secondary data was collected at various stages of this research. These included a review of information from internet sources, newspaper articles, journal articles and official government documents. Documents scrutinized include Ghana Environmental Action Plan; National Environmental Policy; Manual for the Preparation of District Waste Management Plans in Ghana; Environmental Sanitation Policy of Ghana; Ghana Landfill Guidelines and; Guidelines for the Management of Health Care and Veterinary Waste in Ghana. All of these publications were purchased at various sector ministries in the AMA due to the difficulty in accessing library copies. This was made possible by funding from AUCC and CIDA through the Students for Development Internship Program. The fundamental objectives of the reviews were to gain a comprehensive understanding of existing frameworks for managing wastes, biomedical pollutants and the environment in general.

6.6 Data Management and Analysis

Data analysis involves a process of organizing, synthesizing and working with information garnered for the objective of answering the research questions (Bogdan & Biklen 1982). In this study, a combination of both qualitative and quantitative analytical methods was utilized in the management of the case study data. Subsequently, qualitative data was initially transcribed and content analyzed. The data were carefully organized, open-coded and analyzed for common themes. This type of analysis provides a descriptive account of events and allows for cross-checking of information (Babbie, 1989). Some direct quotes from qualitative data are represented in tables in the findings. Statistical data from the survey questionnaires were tabulated using SPPS software and the results represented in the form of graphs and tables in the findings.

Guba (1981) outlines four main criteria for ensuring rigour in qualitative research: credibility, transferability, dependability and confirmability. The credibility criterion seeks to ascertain the congruence of the study to reality and helps to establish trustworthiness in a research (Lincoln & Guba, 1985). In the context of this study, credibility was pursued through a number of means including the use of different data collection methods as well as the use of a wide range of informants. A triangulation process involving the verification of information provided other informants ensured the collection of high quality data from a variety of sources. In order to ensure honesty during the data collection process, participants were given the opportunity to refuse or withdraw their participation at any time during the research. This contributed to credibility by ensuring a free and unhindered collection of data from willing participants.

Transferability deals with the extent to which the findings of a case study can be generalized and applied toward other situations (Guba, 1981). Typically, this is somehow difficult in qualitative research due to the specificity and unpredictability of most social phenomena. The collection of secondary data such as, public documents and newspaper reports helped provide external validity to the primary findings. For instance, it was deduced during the review of public documents that sanitary landfills and proper incineration

technologies are severely limited in Ghana. Therefore, the findings observed in the AMA in regards to the disposal and incineration of urban wastes and biomedical pollutants can be transferred to other parts of Ghana.

Dependability seeks to demonstrate the likelihood of achieving similar results if the study is facilitated at a different time with the same participants. This is one of the underlying thrusts of positivist research. In post positivist research this approach to ensuring dependability constitutes a problem due to the evolving nature of most social phenomena. To offset this challenge, an in-depth description of the methodological approach and the findings has been presented to allow the study to be repeated.

Finally, to ensure rigour through confirmability, several approached were adopted. These include the quelling of bias through triangulation; an in-depth description of the methodological framework including the researcher's assumptions as well as the recognition of the study limitations (Shenton, 2004). A discussion of the study limitations is presented in the next section.

6.7 Study Limitations

Even though the research approach and findings are presented as a clear and carefully organized programme, the study is not without limitations. The single case study approach is often critiqued as having a proclivity to be situation-specific process which lacks a generalizable appeal (Miles & Huberman, 1994; Yin, 1994). In the context of this research, such critiques would hold valid if positivist environmental management frameworks in developing countries have succeeded. Understanding and addressing challenges linked with the management of urban wastes and biomedical pollutants in a developing country context requires a dynamic investigative approach, one that does not present generalizable findings, but rather provides a framework for understanding why and how a particular situation exists. Triangulation assisted in uncovering multiple aspects of the phenomenon under investigation in addition to ensuring validity, accuracy and consistency (Denzin & Lincoln, 2003; Patton, 2002). Thus, even though this research is a single case study, multiple phenomena were investigated.

Additionally, research embedded in post-positivist and interpretivist notions such as this particular study is often critiqued as having the tendency to reflect the bias of the researcher who is principally in charge of data collection and analysis (Hakim, 2000; Yin, 1994). A point of divergence is that post-positivism encourages researchers to acknowledge and address their biases in a case study in order for authenticity to be achieved (Patton, 2002). Notwithstanding the ideological backing offered by post-positivism, several steps were taken to address excessive bias. These include the use of multiple sources as well as the establishment of explicit links between data collected and conclusions drawn (Yin, 1994).

Several challenges were also encountered during the field investigation. Initially, many interviewees were unwilling or unable to participate fully in the interview process due to fear of victimization or reprisal from superiors. In addition to this certain institutions and facilities in the AMA are easily identifiable making the confidentiality agreement a bit challenging. For instance, there is only one official dumpsite, and only one teaching hospital in the entire AMA. Therefore it becomes difficult to document information derived from observation techniques without exposing the facility and institution. In spite of such challenges, much care was taken not to break any confidentiality agreement with individuals. Time management further proved to be a challenge during the field investigation. Many interviewees would show up late for interviews after providing an early schedule. This practice was widespread. In one instance, the research and his assistants had to wait for three hours for an interviewee to show up in his office for an interview.

6.8 Summary of Chapter

This chapter discussed the case study epistemology, design and methodology. The research is grounded in post-positivist epistemology and employs both quantitative and qualitative data collection methods. Approaches to data management and analysis were also discussed. Additionally, the study limitations as well as challenges encountered during the data collection phase of the research have also been addressed.

Chapter 7

Case Study Findings

7.1 Introduction

This chapter presents the research findings. The data presented in the chapter are collated from a variety of sources including public documents, survey questionnaires, personal interviews, focus group discussions and observation processes. Section 7.2 examines the urban governance system in the AMA. This is followed by a review of some of the major environmental and waste management regulations and guidelines in section 7.3. Regulatory frameworks examined in this section include: the National Environmental Action Plan of Ghana; and the National Environmental Policy. Other non-legally binding guidelines reviewed in section 7.3 include: the Manual for the Preparation of District Waste Management Plans in Ghana and Guidelines for the Management of Health Care and Veterinary Wastes in Ghana. Institutional arrangements pertaining to waste management in the AMA is discussed in section 7.4. Here, the emphasis is on the Environmental Blueprint of Accra; principal actors involved in waste management service delivery; amounts and composition of wastes as well as storage, collection, transportation and disposal arrangements. The management of biomedical pollutants generated from healthcare activities in the AMA is discussed in section 7.5. Environmental and human health risks associated with current approaches to the management of urban wastes including biomedical pollutants are assessed in section 7.6. A summary and interpretation of the interview results are presented in sections 7.7 and 7.8 respectively. The views of stakeholders regarding the FUME (see chapter 5) and possible amelioration strategies are highlighted in section 7.9. This is followed by concluding remarks in section 7.10.

7.2 The Urban Governance System in the AMA

The day to day administration of the Accra Metropolitan Area is the onus of Accra Metropolitan Assembly[24] who derive executive, legislative and judicial powers from Legislative Instrument 1500 (L. I. 1500) of the Local Government Act of 1993. The Accra Metropolitan Assembly is constituted of 104-member Assembly members, 70% of who are elected local officials from various sub-metros constituting the AMA while the remaining 30% are appointed. The Accra Metropolitan Authority is headed by a Metropolitan Chief Executive (MCE) who is appointed by the Executive branch of the central government. Although the MCE is appointed, s/he has to be approved by a majority of the Assembly members through a ballot. As a local government body, the mandate of the Accra Metropolitan Authority include: the provision of a sound sanitary and healthy environment; planning and development control of all infrastructure within Accra; provision of educational infrastructure for first and second cycle schools; provision of markets and lorry parks within the Metropolis; e) provision of public safety and comfort; and f) provision of educational infrastructure for first and second cycle schools (AMA, 2010). In regards to sanitation and waste management, the Accra Metropolitan Assembly vests the Waste Management Department[25] (WMD) with the responsibilities of: enhancing the awareness of citizens and business enterprises as to the nature of their responsibilities; facilitating and enabling the participation of the private sector, and communities in waste management activities; promoting minimization through re-use and recycling of waste; setting standards, and issuing regulations and by-laws; enforcing environmental regulations and by-laws; preparing plans and guidelines on the organization of waste management activities and; coordinating sanitation programs in the metropolis. In the discharge of its functions, the Environmental Health and Management Department (EHMD) of the Accra Metropolitan Assembly assist the WMD with enforcement, monitoring and public education.

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[24] Also known as Accra Metropolitan Authority
[25] Established in 1985 by the Government of Ghana with support from the Government of Germany

Funding for the Accra Metropolitan Authority is derived from both internal and external sources. Internally Generated Revenue (IGR) through sources such as; property rates, rents, business registration licences accounts for over 60% of the overall funding of the Accra Metropolitan Assembly. External sources of funding derived from the District Assembly Common Fund (DACF) accounts for 30% of revenue while foreign aid and donor assistance from the World Bank, African Development Bank (ADB), French Development Agency[26] (AFD) and CHF international accounts for 10% of total funding. At the time of this study in 2010, 60-70% of Internally Generated Revenues are allocated toward waste management service delivery in the AMA. Revenue from the District Assembly Common Fund is used to pay the salaries of over half the staff at the Accra Metropolitan Assembly. The salaries of senior level management personnel and a few junior management officials are paid directly by the Government of Ghana. Revenues from foreign aid and donor agencies are invested directly in project-specific ventures such as sewage and liquid waste management.

As a local government institution, the Accra Metropolitan Assembly works directly under the Ministry of Local Government and Rural Development who acts on behalf of the Government of Ghana. The Greater Accra Regional Coordinating Council (GARCC) also monitors the activities of the Accra Metropolitan Assembly by ensuring that central government policies are implemented. Within the local government itself, the Accra Metropolitan Authority is required to act in close consultation with Area and Town Councils, Unit Committees and Communities in the AMA. These different bodies are required to provide oversight on the activities of the local government authority.

7.3 Regulatory Arrangements: Environmental and Waste Management in Ghana

Prior to the Rio Summit on the Environment and Development in the early 1990s, regulatory frameworks pertaining to environmental management in Ghana can be described

[26] Also known as Agence Française de Développement

as feckless and virtually non-existent. This trajectory took a dramatic turn in the period following the aftermath of the Rio Conference when the central government started putting in place measures aimed at protecting the environment from degradation. Subsequently, the Environmental Protection Council (EPC) was replaced with the Environmental Protection Agency (EPA) under an Act of Parliament (490) in 1994 and vested with the responsibility of enforcing, monitoring and controlling environmental quality in Ghana. The post-Rio era witnessed the enactment of a number of regulatory frameworks by various central government ministries and agencies aimed at protecting the environment and human health. These include the National Environmental Action Plan (NEAP); Environmental Sanitation Policy (ESP); the National Environmental Policy (NEP); National Environmental Quality Guidelines (1998); Local Government Act 462 (1990); Ghana Building Regulations LI. 1630 (1997); Vaccination Ordinance Cap 76; Quarantine Ordinance Cap 77; Mosquito Ordinance Cap 75; Infectious Disease Ordinance; Food and Drugs Law 305b (1992); Environment Protection Act 490 (1994); Environmental Assessment Regulation 1652 (1999); and the Mortuaries and Funeral Facilities Act 563 (1998). Additionally, environmental management guidelines such as, the Manual for the Preparation of District Waste Management Plans in Ghana; Guidelines for the Management of Health Care and Veterinary Waste in Ghana, Ghana Landfill Guidelines were developed by the EPA with the fundamental objective of protecting the environment and human health. A number of these frameworks are specifically linked to waste management and are reviewed extensively in this section.

7.3.1 Overview of Ghana's National Environmental Action Plan (NEAP)

The National Environmental Action Plan (NEAP) entrusts the government of Ghana with the onus of implementing environmental policy actions deemed congruent with the ideals of sustainable development. Priority areas embodied in the plan include issues relating to land and water management, forestry, wildlife, marine and coastal ecosystems; mining, manufacturing industries, hazardous chemicals and human settlements. The design of the NEAP was facilitated by a committee of experts appointed by the government with the

objective of providing a coherent framework for mitigating environmental risks facing the country. These experts were vested with the following responsibilities:

- assessing the state of knowledge;
- identifying data gaps;
- reviewing existing legislation and policy recommendations that have been made in the past, and proposing a set of needed policy actions;
- making proposals for monitoring environmental change in relation to development activities;
- reviewing projects under previous public investments programs and make recommendations on their environmental suitability or otherwise;
- reviewing institutional arrangements for the implementation of recommended policies, gaps, overlaps and strategies for strengthening institutional capacities.

Evidently, there is no explicit mention of waste management as a major priority area. Initially, many key stakeholders including the general public, healthcare providers as well as representatives of the IC&I sectors were excluded in the process. However, some selected stakeholders were invited to participate in discussions pertaining to the draft proposal of the NEAP. These include: District Assemblies (DAs), Non-Governmental Organizations (NGOs) and Government Officials. Members of the general public as well as representatives from the industrial, commercial and institutional sectors were not invited. The final document of the NEAP adopted after conference outlines approaches to addressing legal and institutional hurdles militating against environmental management with no specific reference to (biomedical) waste pollution. In the final draft of the NEAP, experts proposed the enactment of a national environmental policy (NEP) which is reviewed next.

7.3.2 Overview of the National Environmental Policy (NEP) of Ghana

The National Environmental Policy (NEP) of Ghana was initially proposed in the NEAP as a framework for addressing environmental problems in the country and is predicated on a view of a healthy environment as intrinsically linked to economic prosperity. Subsequently, the overarching objective of the NEP is to forge new directions in environmental management. Within this overarching objective are several underlying goals. These include:

- maintaining ecosystems and ecological processes essential for the functioning of the biosphere;
- ensuring sound management of natural resources and the environment;
- adequately protecting humans, animals plants and their biological communities and habitats against harmful impacts and destructive practices and preserve biological diversity;
- guiding development in accordance with quality requirements to prevent, reduce and as far as possible, eliminate pollution and nuisances;
- integrating environmental considerations in sectoral, structural and socio-economic planning at the national, regional, district and grassroots levels
- seeking common solutions to environmental problems in West Africa, Africa and the world at large.

In pursuit of its stated objectives, the NEP targets a number of specific areas including the management of environmental resources; comprehensive pollution control; the development of appropriate instruments; environmental education; monitoring and international co-operation. The major objectives under these policy areas include:

- ensuring an optimum sustainable yield in the use of resources and ecosystems;
- the use of the most cost-effective means to achieve environmental objectives;
- use of incentives in addition to regulatory measures;
- delegation of decision-making and action to the most appropriate level of government;
- polluter pays for the cost of preventing and eliminating pollution and nuisances; public participation in environmental decision-making;
- International co-operation.

On the issue of toxic waste pollution, the NEP proposes the adoption of a robust and comprehensive policy aimed at ameliorating the situation by laying emphasis on reduction, recycling, reuse and safe disposal.

7.3.3 Overview of Ghana's Environmental Sanitation Policy (ESP)

The Environmental Sanitation Policy (ESP) of Ghana was established in recognition of the need for the attainment of good health, productivity and welfare of the citizenry through sound and prudent sanitary policies. Essentially, the ESP is based on the following premises:

- the Principle of environmental sanitation is a public good;
- the principle of environmental sanitation is an economic good;

- the polluter must pay for the cost of dealing with pollution;
- the principle of cost recovery must ensure value-for-money effectiveness and efficiency;
- the principle of subsidiarity must serve to ensure participatory decision-making at the lowest level in society;
- the principle of improving equity and gender sensitivity;
- the principle of recognizing indigenous knowledge, diversity of religious and cultural practices;
- the precautionary principle must be applied to deal with potential threats to the environment
- the principle of community participation and social intermediation.

Specifically on the management of biomedical pollutants, the ESP mandates generators of such wastes to establish effective institutional arrangements for primary storage, treatment, transportation and disposal practices. The policy states inter alia:

All health institutions shall establish an institutional waste management system for the primary storage of wastes. They shall be required, where possible, to pretreat healthcare waste (e.g. by autoclaving) prior to storage. Domestic type waste shall be stored separately from healthcare wastes (infectious or hazardous hospital wastes). Similar procedures shall be followed by other generators of hazardous wastes. Separate collection of hazardous wastes and healthcare wastes shall be provided by all District Assemblies or by other arrangements approved by the Assembly. Transportation of such wastes shall be in closed compaction vehicles which shall be cleaned and/or disinfected at the end of every collection day. The wastes shall be incinerated and/or buried in designated sections of landfills or other approved waste disposal sites, in accordance with the MLGRD guidelines.

The policy vests district, metropolitan and municipal assemblies with the responsibility of collecting and safely disposing urban wastes to avoid accumulation and decomposition. Under the policy, Assemblies are required to provide communal storage sites in neighbourhoods with no access to house to house collection. Households are also required to provide appropriate bins for the storage of waste. Additionally, the ESP charges Assemblies to maintain an in-house capacity to provide at least 20% of waste management services directly to consumers and contract out, or franchising part of their services. The ESP

further stipulates that Assemblies must provide suitable treatment and disposal sites such as landfills, composting facilities, waste stabilization ponds, trickling filters and septage treatment plants. Such sites must be carefully chosen and well managed to prevent adverse environmental and human health effects.

7.3.4 Overview of the Guidelines for the Management of Health Care and Veterinary Waste in Ghana

The *Guidelines for the Management of Health Care and Veterinary Waste* in Ghana is the only public document in Ghana designed to address the management of biomedical pollutants from healthcare activities. Its major objectives include providing a basis for policy formulation as well as setting out appropriate institutional and administrative framework and procedures for managing biomedical pollutants. Subsequently, the Guidelines provide recommendations for the handling, storage, collection, transportation, treatment and disposal of biomedical wastes generated in healthcare facilities (see fig. 7.1). In its standard disposition the Guidelines appear to be quite heavy on rhetoric and less on substance in the sense that it provides no effective means of monitoring, evaluating and assessing the effectiveness of its recommendations. For example, the Guidelines direct generators of biomedical pollutants to apply disinfection, incineration and landfilling techniques to treat and dispose of certain types of pollutants. Yet, there is neither a single sanitary landfill nor a single properly functioning incineration technology in the entire Accra metropolitan Area. In addition, many healthcare facilities do not have access to technologies for disinfecting biomedical pollutants. Furthermore, the Guidelines were prepared by an inter-sectoral technical team drawn from major government agencies and healthcare facilities.

Table 7.1: Recommended treatment and disposal options for biomedical pollutants prepared by the EPA

Waste Type	Description of Waste	Treatment and Disposal Options
A	**General Waste**	Landfill
B	**Infectious Waste**	
B1	Sharps	Steam disinfection/incinerate
B2	Patient Waste	Incinerate
B3	Culture/Specimen	Incinerate/sterilize
C	**Pathological/Organic** **Human Tissues**	Incinerate Steam disinfection
D	**Hazardous Waste**	
D1	Pharmaceutical Waste	Incinerate
D2	Photographic Chemical Waste Photographic Developer Fixer Solution X-ray Photographic Film	Recycle/ reuse Neutralized Incinerate
D3	**Radioactive Waste**	
	Solid- combustible/compactable Non-combustible/non compactable Liquid- Aqueous Spent sealed sources	Compaction, decay storage, landfill Decay storage, landfill, cementation, disposal in repository Return to supplier
D4	**Laboratory Waste**	
D4.1	Acids	Dilute with water and neutralize with alkali
D4.2	Alkalis	Neutralize with acid
D4.3	Solvents	Distillation
D4.4	Organic Substances	Dissolve solid compounds and discharge in septic tanks Mix carefully with much water before draining in septic tanks
D4.5	Heavy metal e.g., mercury	To be recycled or reuse
E	**Incinerated Ash** **Sludge**	Landfill Landfill

Source: EPA, 2002

7.3.5 Overview of the Manual for the Preparation of District Waste Management Plans in Ghana

The *Manual for the Preparation of District Waste Management Plans in Ghana* was developed by the Environmental Protection Agency (EPA) of Ghana. The main objective of the *Manual* is to provide a deliberate framework for waste management planning and decision making (see table 7.2). In pursuit of its strategies the Manual puts forward a number of key recommendations including the following:

- the constitution of an inter-sectoral Technical Team;
- a review of current planning data for waste management; consultation with key stakeholders; identification and evaluation of management options;
- making projections and setting targets; prioritization of waste management options;
- determining components of the implementation of the plan; estimating the costs of waste management services;
- implementation of the waste management plan and; monitoring and reviewing progress of waste management decisions.

Similar to most of the public documents pertaining to the management of wastes in the environment, citizen participation is not mentioned in any meaningful way in the Manual for the Preparation of District Waste Management Plans in Ghana.

Table 7.2: Recommended Strategies for improved waste management practices in Ghana.

Objectives	Activities	Collaborating Agencies
Improve Policy Framework on Waste Management	Convert draft guidelines on waste management into Regulations Prepare additional regulations to improve waste management. Review existing legislations, bylaws to reflect current trends.	MES, MLGRD, MOH MES, (EPA, CRIR), DAs MLGRD (EHMD, DAs) MOH, DAs
Improve Planning and Implementation of Waste Management Programmes	Prepare waste management plans Select/acquire sites for waste management facilities (transfer stations, waste disposal sites, sewage treatment and composting facilities) Identify and involve various stakeholders in waste management activities Conduct public awareness	All District Assemblies DAs, EPA, T& CPD Geological surveys, EHMD DAs, EPA, EHMD

Source: EPA, 2002

7.4 Institutional Waste Management Practices in the Accra Metropolitan Area

This section provides an account of institutional arrangements pertaining to urban waste management practices in the Accra Metropolitan Area (AMA). The discussion in this section sheds light onAccra's environmental blueprint; actors involved in service delivery; waste generation and composition and; current management practices. A critique of the findings is presented at the end of the discussions.

7.4.1 Accra's Environmental Blueprint

The current environmental blueprint pertaining to waste management in Accra is based on the implementation of a Waste-to-Energy program. As part of the plan, energy generated from municipal solid waste (MSW) will be sold to the national electricity grid and the profits shared between the Accra Metropolitan Authority and private operators of the scheme. In terms of liquid waste management, the blueprint reiterates plans to repair, replace, construct and link new drainage systems in new communities to the existing plant, which happens to be an aquatic ecosystem. Interviewee 11 who is a senior level local government official reiterated that there are on-going efforts on the part of the Accra Metropolitan Assembly, the Ministry of Local Government and Rural Development (MLGRD) and the World Bank to complete the Korle Lagoon[27] Ecological Restoration Project. As of the third quarter of 2011, the implementation of the tenets of the AMA's waste management blueprint is yet to take off. Interestingly, the blueprint makes no mention of waste minimization, recycling and composting as viable strategies for managing wastes.

7.4.2 Waste Management Service Delivery in the AMA: Major Actors

The provision of waste management services in the AMA is currently a preserve for the public, private and informal sectors. The public sector role is assumed by the Waste Management Department (WMD) of the Accra Metropolitan Assembly which is primarily responsible for overseeing all aspects of service delivery in Accra. Effectively, the

[27] An aquatic ecosystem in Accra

responsibilities of the WMD include the enactment of bylaws, public education and policy enforcement. The WMD is also responsible for contracting out services to the private sector as well as the selection and maintenance of waste disposal sites in the metropolis.

The role of the private sector mainly involves the collection and disposal of wastes generated in the city. Currently, there are more than 15 private sector waste management companies operating in the AMA, 3 of whom have been contracted to collect and dispose wastes from large government and quasi-government healthcare facilities. Private Sector Participation (PSP) in waste management service delivery is widely believed to have gained prominence in light of the inability of the WMD to perform its duties efficiently. Coupled with this is the imposition of neoliberal economic policies such as, the structural adjustment program (SAP) on Ghana by the World Bank and funding agencies. As part of the stipulations of the SAP, privatization of state owned enterprises was initiated and the private sector has become part of the waste management service delivery process in Ghana since the 1980s and early 1990s.

The informal sector provides waste management services in areas not fully covered by the formal public and private modes of service delivery due to logistical or infrastructural deficiencies. In slums and squatter settlements with poor road networks as well as densely populated marketplaces, informal waste carriers known in the local parlance as, *kaya-boorla* meaning waste labourers, operate by means of wheelbarrows, four-wheel trolleys, head pans and donkey carts to collect wastes. The informal sector also participates in sweeping of market places in the AMA. This group of service providers are not formally organized and operate as private sector actors.

7.4.3 Waste Generation Rates and Characteristics

Urban officials in the AMA estimate the amount of waste generated in the metropolis to be in excess of 2000 metric tonnes each day. Although a sizeable amount of such wastes are putrescible organic matter, the presence of plastic residue was found to be ubiquitous in the composition of wastes generated in the AMA. This finding challenges existing data that suggests that the vast majority of wastes generated in the AMA consist mainly of organic

matter. The interviews with multiple stakeholders reveal that since the 1990s the use of polythene bags as primary packaging materials has been on the ascendency. Prior to this period vendors packaged cooked food in biodegradable leaflets and drinking water was dispensed in reusable cups. Awareness of the human health risks associated with such practices resulted in the packaging of drinking water in mini plastic sachets which are known locally as *pure-water*. Polythene bags eventually became the packaging material of choice for many retailers especially food and water vendors in the AMA. The high patronage of *pure-water* due to the heat and humidity of the tropical urban environment results in the generation of massive volumes of plastic residue which have significantly transformed the composition of wastes generated in the AMA.

7.4.4 Waste Storage

The primary method of storing wastes in the AMA is by means of central storage bins provided by the WMD and private waste management service providers (see fig. 7.1). Such communal storage bins were found to be located predominantly in middle and low income areas, market places, squatter settlements and slums. A close observation of the storage bins reveals several problems including the lack of top-covers which allows waste to fly-off, causing littering. The central storage containers were also found to have no proper lining resulting in the indiscriminate discharge of leachate into the environment. In addition, the towering heights of the storage containers provide no effective means of waste deposit. This results in a situation where users have no choice but to deposit the waste beside the container, creating an environmental nuisance in many neighbourhoods. Moreover, a mephitis odour was observed to be emanating from most of the storage containers due to the high content of organics as well as human excreta. Furthermore, the presence of domestic livestock was observed feeding in and around many communal storage containers.

Figure 7.1: Centralized waste storage receptacle in Accra, Ghana. Photo by Squire, 2010

The problem of ineffective waste storage practices identified in the AMA was echoed in the responses provided by survey respondents. When asked to give their opinion regarding institutional waste storage arrangements in the AMA, 95% (361/380) of survey respondents described the situation as very bad, while 5% (19/380) think it bad. Interestingly, none of the respondents rated waste storage arrangements as excellent, very good or good even though they were presented with such choices. Such dissatisfaction is due to a plethora of reasons including the poor design of the storage containers, poor collection practices and concerns for the urban aesthesis.

7.4.5 Waste Collection

The collection of urban wastes in the AMA is based on curb-side and centralized container collection (CCC) methods. The curb-side method typically involves house-to-house collection of refuse at a predetermined time, usually every two weeks or once a month, depending on the type of agreement between the service provider and the residential unit. This type of service is mostly provided by private waste management companies contracted

by the Accra Metropolitan Assembly through the Waste Management Department (WMD). Service delivery tends to be concentrated in affluent and some middle income neighbourhoods of the city. The (CCC) system is mostly provided in most middle and low income areas, marketplaces, slums and squatter settlements in the city. Under the CCC system, large metal containers are placed at designated spots where residents dispose of their waste for onward collection to disposal sites. Collection services are provided by private waste management companies who are paid according to the total tonnage collected by the Accra Metropolitan Assembly.

Urban waste collection practices in the AMA were found to be laden with major problems. In some areas, wastes have been left uncollected for several weeks resulting in accumulation in residential areas, market places and central storage locations (see fig. 7.2). This raises major concerns around environmental and public health. The high organic content of the waste composition contributes to the discharge of unpleasant odours into the atmosphere. Resultantly, all survey respondents expressed dissatisfaction regarding institutional arrangements pertaining to waste collection in the metropolis. Approximately 85% (323/380) described the situation with waste collection in Accra as very poor while 15% (57) labelled the situation as bad. Giving an account of the situation, interviewee 2, an administrator of a private healthcare facility stated: *"They don't come on time sometimes the garbage stays in front of my house for months until we can't take it no more. When that happens we contract the informal sector carriers to do the collection"*. Commenting further on the situation interviewee 5, a government sector healthcare employee stated: *"I don't think they know what they are doing. They are just a bunch of people with money and political connections who have been awarded lucrative contracts by their friends. They have no idea what they are doing"!*

Figure 7.2: Infrequent waste collection practices in Accra, Ghana. Photo by Squire, 2010

Such poor conditions of service have created a sense of distrust between many residents, private waste contractors and the Accra Metropolitan Assembly. When asked who is responsible for the poor collection of wastes in the metropolis, 45% (171) of respondents blamed the Accra Metropolitan Authority, while 40% (152) laid the onus on the private contractors and 15% (57) think both the metropolitan authority and private waste contractors are liable. On the flip side, most survey respondents 60% (228/380) believed the informal sector is more reliable when it comes to waste collection, 15% (57) think the private contractors are more reliable and 20% (76) believe none of the service providers are reliable. Interestingly, many respondents view the informal sector waste management service providers in a more positive light than the WMD and private contractors.

7.4.6 Transportation of Wastes

Wastes collected in the AMA are transported to disposal sites by means of hydraulic compactor vehicles, and multi-lift trucks. Some of the vehicles were seen to have no top covers, allowing waste to fly-off during transportation, while others use nets as covers.

Within the informal sector, waste is transported to central storage containers and final disposal sites by means of four-wheeled manual trolleys, wheelbarrows and head pans. A site visit to one of the compounds of the WMD revealed the presence of abandoned waste management service vehicles in need of repairs and maintenance (see fig. 7.3 - 7.6).

Figures 7.3-7.6: Abandoned waste management service vehicles in the AMA, Ghana. Photos by Squire, 2010

7.4.7 Incineration and Disposal

Presently, there is neither a functional municipal waste incinerator nor a sanitary, engineered landfill in the entire city of Accra. Currently, the Accra Metropolitan Assembly has designated an abandoned stone quarry near Anyaa[28] on the outskirts of Accra as the official waste disposal dumpsite. Prior to the selection of the present

[28] A suburb in Accra

dumpsite, wastes generated in Accra were transported to the Oblogo dumpsite which reached its peak a few years ago. The official dumpsite has no effective leachate collection, gas extraction and drainage systems due to poor planning. A leachate pond was found to have been formed in close proximity to the dump. Wastes deposited in the dump are neither placed in cells nor covered with top-soil although the presence of a few service vehicles were seen to be routinely compressing wastes to ensure the maximum use of space. The presence of a large and organized group of scavengers including women and children were also observed at the waste dumpsite. None of the scavengers were seen to be using any protective gear.

Figure 7.7: An unauthorized waste dump in the AMA, Ghana. Photo by Squire, 2010

In addition to the official dumpsite, there are a number of illegal and unauthorized dumpsites in almost every part of the city (see fig. 7.7). The majority of such dumps are located in very close proximity to human settlements, aquatic ecosystems and commercial establishments. In one particular instance, a mechanic's shop and a food vending kiosk was observed a few yards from an unauthorized waste dump. Scavenging by both human and livestock was also found to be prevalent in unauthorized waste dumps in Accra. Most

of the unauthorized waste dumps are patronized by area residents and informal waste carriers who in some cases pay use fees to a dump attendant.

7.5 The Management of Biomedical Pollutants in the Accra Metropolitan Area (AMA)

In this section the management of biomedical pollutants generated in the course of healthcare activities in the AMA are examined.

7.5.1 Healthcare Service Delivery in the AMA

The Ministry of Health and Ghana Health Services are the regulatory agencies responsible for overseeing healthcare service delivery in the AMA. Presently, there are approximately 3011 healthcare facilities in Ghana, 466 of which are situated in the Greater Accra region (see table 7.3). The Accra Metropolitan Area (AMA) is home to 218 of these healthcare facilities which are distributed across six of the 11 major sub-districts that constitute the AMA (see table 7.4). Additionally, there are scores of pharmaceutical retail shops, animal care centres, as well as chemical and pharmaceutical manufacturing facilities in the AMA.

Table 7.3: Number and types of healthcare facilities in the AMA

Sub Metro	Facility Type- Hospital	Facility Type-Health centre / Post	Others
Okaikoi	2	19	6
Osu Klottey	3	27	7
Kpeshie	7	19	11
Ayawaso	9	33	15
Ashiedu Keteke	1	19	7
Ablekuma	6	13	14
Total	**28**	**130**	**60**

Public healthcare facilities are classified as tertiary, regional, district hospitals, health centres and community health centres (see table 7.4). Tertiary institutions are usually large and are not limited by the amount of beds and are constituted of various departments. Such facilities tend to provide specialized care and also serve as training institutions. Healthcare facilities with regional classification often have a bed capacity of approximately 250 to 300 and are limited by the type of care they provide. District hospitals are also limited by the number of beds and usually have a bed capacity of 120. These include most private clinics. Health centres provide mainly outpatient services such as, the treatment of minor illnesses and maternity services. Such health centres are generally overseen by trained medical assistants. Community health centres are those vested with the responsibility of dispensing first aid in the community. These health centres are managed by trained community health assistants. The activities of these various healthcare providers are generally overseen by the Ministry of Health (MOH), which is assisted by the Ghana Health Service (GHS). In matters pertaining to animal healthcare such as veterinary services, the Ministry of Food and Agriculture (MFA) assumes responsibility.

Table 7.4: Classification of public healthcare facilities in Ghana

Type of Facility	Main Features
Tertiary / Teaching / Specialist Hospitals	▪ Constituted of various departments ▪ Provides specialized care ▪ Serves as training institutions ▪ Not limited to number of beds
Regional Hospital	▪ Located mainly in regional capitals ▪ Usually has a bed capacity of 250-300
District Hospitals	▪ Usually administered by General Medical Officers ▪ Bed capacity of 120
Health Centres	▪ Provides mainly outpatient services e.g., minor illnesses and childbirth ▪ Managed by Medical Assistants
Community clinics / Maternity / Child health centres	▪ Managed by Community clinic Attendants ▪ Mainly dispenses First Aid

Source: EPA, 2002

7.5.2 Generation of Biomedical Pollutants

Urban Authorities in the AMA as well as healthcare institutions were found to keep no records pertaining to the quantity and composition of biomedical pollutants generated in the metropolis. Authorities estimate the amount of pollutants generated to be part of the 2000 metric tonnes of municipal wastes generated daily. Generally however, the quantity of biomedical pollutants produced in healthcare facilities can be determined by a number of factors including size and instrumentation. Being the capital city of Ghana, the AMA is home to one major teaching hospital, several polyclinics, and hundreds of private clinics. A survey of six major hospitals by the Waste Management Department (WMD) of the Accra Metropolitan Assembly in 1992 revealed the generation of approximately 1.2 kg of BMW per bed, per day. Based on this figure, it can be conservatively estimated that roughly 95,484 kg of biomedical pollutants are generated in the AMA each day.

7.5.3 Legal and Institutional Arrangements

Legal provisions regulating the management of biomedical pollutants in the AMA are enshrined in the Environmental Sanitation Policy (ESP) of Ghana. The policy states inter alia:

> All health institutions shall establish an institutional waste management system for the primary storage of wastes. They shall be required, where possible, to pretreat healthcare waste (e.g. by autoclaving) prior to storage. Domestic type waste shall be stored separately from healthcare wastes (infectious or hazardous hospital wastes). Similar procedures shall be followed by other generators of hazardous wastes. Separate collection of hazardous wastes and healthcare wastes shall be provided by all District Assemblies or by other arrangements approved by the Assembly. Transportation of such wastes shall be in closed compaction vehicles which shall be cleaned and/or disinfected at the end of every collection day. The wastes shall be incinerated and/or buried in designated sections of landfills or other approved waste disposal sites, in accordance with MLGRD[29] guidelines.

[29] Ministry of Local Government and Rural Development

Thus, the ESP requires generators and handlers of biomedical pollutants to adopt safe and effective management practices in accordance with recommendations provided by the local government authority through the central government. However, the field investigation revealed widespread non-compliance to such policy directives. Consequently, the management of biomedical pollutants is not prioritized in almost all of the healthcare facilities surveyed. Approximately 80% of the healthcare facilities surveyed during the field investigation have no internal guidelines for managing biomedical pollutants. In facilities where there are guidelines, enforcement and compliance were found to be woefully inadequate.

Interestingly, the management of biomedical pollutants is not mentioned in the environmental blueprint of Accra. The reason for the omission is explained by interviewee 11, a senior level local government official as follows:

> We will have to tackle the basics first. Our first approach is that since the bulk of the refuse comes from households, we will have to tackle household waste first, once we have established control, we can move into the second phase that is, dealing with the hospital waste. I am concerned about the medical area refuse but right now, we don't have the equipment and anything to deal with that so it is better to let it go the way it is going and then once we have control over how we are dealing with household refuse, other ones will follow. For the public, all they see is waste that litters the streets, you understand, I see the technical implications of what you are saying but for the public what they see every day is the waste on the street, the stench and the flies and the mosquitoes so that's what everybody will talk about. We have to tackle the bigger issue and then divert to tackle what you are saying (biomedical pollutants). Once we get this waste to energy going, it will open doors for these other issues.

Ostensibly, despite its potential to cause infection and contamination more than any types of waste, urban officials do not consider the management of biomedical pollutants as a priority.

7.5.4 Segregation

Segregation as a management strategy for biomedical waste management strategy is generally limited to certain classes of pollutants mainly, human anatomical and sharp wastes. Source separation of anatomical wastes such as human body parts, organs, aborted foetuses, placentas and tissues were found to be prevalent in 90% of all the facilities surveyed. Only

20% of facilities engaged in source-separation of laboratory wastes while human blood and bodily fluids were separated in 20% of facilities. Sharp objects including needles scalpels and operating blades are segregated in 40% of healthcare facilities. Segregation practices were found to be inconsistent across different wards and departments. Some wards segregated sharp wastes while others within the same facility did not. In 100% of healthcare facilities surveyed, all biomedical wastes with the exception of human bodily parts are comingled during the collection and transportation process. In facility number 2, segregation was carried out by waste management personnel at the central storage unit for the purpose of recovering recyclables. Such recyclables are routinely sold to junk buyers who in turn sell them to market women for the storage of foodstuff, palm-oil, honey and water. No prior sterilization of the receptacles is carried out, raising concerns about the potential for contamination.

7.5.5 Storage

Similar to the issue of segregation, storage of biomedical pollutants were found to be inconsistent in all 100% of the healthcare facilities surveyed. In some wards, within both government and private healthcare facilities, anatomical and sharp wastes were stored separately while all other classes of biomedical pollutants are commingled. Waste storage methods were also found to be inconsistent across various wards. In facility number 2 for example, sharps such as needles and blades are stored in standard puncture proof container in one ward, and in cardboard boxes in another. A similar situation was observed in facility number 3 where sharp objects are stored in metal containers in one ward and plastic containers in another. Generally however, the primary method of storing biomedical pollutants within individual wards in all ten facilities is by means of cardboard boxes, standard plastic containers and metal bins. In many instances, storage bins used for the storage of anatomical parts inside of the wards were found to be lined with plastic bags to avoid spillage. In 90% healthcare facilities, metal bins used for the storage of non-anatomical wastes were found to be not lined with plastic bags. Outside of the wards, biomedical pollutants are stored in large metal or plastic drums. This was found in 90% of government and 100% of private healthcare facilities. Only 10% of healthcare facilities stored biomedical

pollutants in metal containers similar to the ones used for storage of municipal wastes (see fig. 7.13). These containers are not properly lined and have no top covers, exposing wastes to spill over and attract vermin. Additionally, only 20% of healthcare facilities within the government sector had access to secure on-site storage facilities. Most of the storage facilities are not utilized for the purposes for which they were intended for. In facility number 4, the centralized storage area is abandoned and several workers were seen relaxing on benches in the storage room.

Figure 7.8: Onsite Storage of Biomedical Pollutants at a Healthcare Facility in Accra. Photo by Squire, 2010

7.5.6 Transportation

Biomedical pollutants are transported from the ward to treatment and disposal facilities by means of wheelbarrows and manual lifting in 100% of both government and private healthcare facilities. External transportation outside of the wards is facilitated by private waste management companies and informal carriers. Only 10% of healthcare

facilities in the government sector were found to have contracted out waste collection services to three private waste management companies. These companies were supposed to use special vehicles for the collection of biomedical pollutants although this was not found to be the case. Subsequently, 90% of government healthcare facilities engage the services of regular private waste management companies for waste collection.

7.5.7 Treatment

Treatment of biomedical pollutants is carried out in only 20% of government healthcare facilities and 0% of private institutions. In facilities where treatment is carried out, a large measure of inconsistency was observed. In facility number 7 for example, it was observed that infectious biomedical pollutants particularly, anatomical residues were encapsulated prior to disposal. However, liquid biomedical pollutants including blood products are emptied directly into the drain without treatment. Only 20% of government and 10% of private healthcare facilities had technologies such as autoclaves and microwaves for treating biomedical pollutants prior to disposal although most are not utilized. Facility number 7 and 8 were the only ones found to have access to operational autoclaves and microwaves for disinfecting infectious pathogens in BMW. Within the private sector, facility number 1 was the only one that was found to use needle destruction technologies. Generally however, all healthcare facilities in both the government and private sectors do not practice effective treatment of biomedical pollutants prior to disposal. In one particular facility, waste water from the hospitals main mortuary is routed directly into the municipal drain without treatment (see figure 7.14). The presence of solid wastes in the drains has caused the waste water to be stagnated. Domestic livestock including goats and poultry were observed drinking from the drain after feeding on an open dump located directly adjacent to mortuary. Some urban farmers operating within the perimeters of the healthcare facility used the waste water as a source of irrigation

Figure 7.9: Untreated biomedical pollutants in an uncovered above-ground drain. Photo by Squire, 2010

7.5.8 Rudimentary Incineration and Crude Burning

Rudimentary incineration and crude burning of biomedical pollutants were found to be commonplace in 100% of government and 80% of private healthcare institutions. Only 20% of government healthcare facilities had access to on-site incineration technologies while none (100%) of the private institutions have access to incineration technology. Most of the incineration technologies in government institutions were found to be in obsolete condition and operated in a rudimentary fashion or were simply inoperable. Facility number 2 has access to two separate incinerators, one specifically for treating anatomical residue such as amputated human bodily parts and the other for general wastes (see figs. 7.15-7.16). Both incinerators were found to be in obsolete condition and generate significant volumes of ash.

Figure 7.10: Onsite incineration technology for treating anatomical residue in a healthcare facility in the AMA. Photo by Squire, 2010

Figure 7.11: Mass Burn Incinerator at a Healthcare Facility in Accra. Photo by Squire, 2010

Additionally, there was no air filtering system installed on any of the incinerators resulting in the emission of thick clouds of smoke during incineration. The mephitis odour around the vicinity of some hospital incinerators was conspicuous, raising major concerns regarding cleaning and disinfection procedures. One of the incinerators is located on an open dump and the presence of both mobile and stationary food and drinking water vendors were observed in close proximity. In facility number 7, it was learnt that the onsite incinerator has been broken down for several years. Resultantly, the incineration rooms have been converted to human living and storage quarters and some workers were observed relaxing in spaces designated for incineration or in close proximity.

In all private healthcare facilities biomedical pollutants are deposited in black plastic bags and placed in the main waste container for onward collection by private waste companies and informal carriers. Interviewee 23 reiterated that the Ministry of Health has issued directives to private healthcare facilities to transport their infectious wastes to larger government facilities for incineration. However, none of the private healthcare providers interviewed during the research follows this government directive citing lack of resources. Resultantly crude burning of biomedical pollutants is rampant in healthcare institutions in both the private and public sectors. As noted by interviewee 23:

> The Ministry of Health recommends that we take infectious and hazardous residue to the nearest hospital where there are incinerators. In my case the nearest hospital is the polyclinic. However, the incinerator at the polyclinic is not functioning and even if it is, there are no vehicles to transport the wastes to the polyclinics and the private waste contractors do not perform such services. Therefore, we simply put them (infectious and hazardous wastes) in the waste bin and are hauled by the waste company. At times when they don't show up, we employ the services of individual carriers (informal) carriers.

When asked if they know where informal carriers deposit the wastes the interviewee remarked: "to be very honest we don't know, as long as the waste leaves this compound, we are okay". In most cases, onsite crude burning areas within healthcare facilities have resulted in mountainous heaps of refuse, some partially burnt. In 20% of private healthcare

institutions, biomedical pollutants are burnt in metal containers located at the back of the facility.

Figure 7.12: Crude burning of biomedical pollutants at a healthcare facility in the AMA. Photo by Squire, 2010

7.5.9 Onsite Open Dumping

Onsite open dumping of biomedical pollutants was found to be prevalent in 90% of government and 20% of private healthcare facilities in the AMA. Government operated facilities tend to be bigger spatially and rarely utilize the services of informal waste carriers. In contrast, private healthcare facilities are smaller and frequently use the services of informal carriers. The wastes deposited in onsite dumps are regularly burnt to reduce volume and toxicity. A close observation of onsite dumps in several healthcare facilities revealed the presence of partially burnt biomedical residue such as, blood soaked bandages, hypodermic needles and discarded pharmaceutical products. The emissions of thick clouds of smoke into the atmosphere were also observed. In some of the healthcare facilities (approximately 10%), human anatomical wastes are encapsulated with immobilizing agents such as lime and bleach

prior to final disposal in dumps. However, this was not found to be common place. Some administrators of private healthcare facilities alluded to dumping anatomical wastes including aborted foetuses in residential septic tanks and allowed to decompose. At 70% of government healthcare facilities, the presence of people and livestock in close proximity to the dumps was observed. In facility number 1 for example, a thriving urban agricultural practice was noticed in close proximity to the dumpsite. In figures 7.10 an onsite open dump located in a government healthcare facility is depicted.

Figure 7.13: Onsite Open Dump at a Healthcare Facility in Accra. Photo by Squire 2010

7.6 Assessment of Environmental and Human Health Risks

The poor and deplorable waste management practices in the AMA were found to have contributed to adverse risks to the environment and human health. An assessment of such risks is presented in this section.

7.6.1 Environmental Risks

All 100% of survey respondents believe ineffective waste management practices constitute a risk to ecosystems. The site observation revealed that in many instances, waste pollution has contributed to significant degradation of marine and freshwater ecosystems in the AMA. A notable example is the Korle[30] lagoon ecosystem. The Korle lagoon used to be a freshwater ecosystem in Accra that has undergone significant degradation and alteration as a result of waste pollution. In the past, the lagoon served as one of the primary sources of freshwater fishes and provided income for local fishermen and fish mongers. Currently, the lagoon does not have any consumable fish stock and its ecological landscape is significantly degraded as a result of waste pollution. Despite ongoing attempts to restore the lagoon to its natural state over the past 15 years, not much success has been attained.

The *Densu*[31] River is another ecosystem that was found to be negatively impacted as a result of the ineffective management of wastes in Accra. Ironically, the Densu river ecosystem serves as a drinking water source for parts of Accra and was also in close proximity to one of the cities authorized waste dumps. Providing an account of the situation, interviewee 8 lamented *"At times the people block the road to prevent waste vehicles from entering the landfill because leachate was running freely through the village into the downstream end of the Densu River. All the streams around the area are dead now"*. In addition, a visit to the *Kpeshie* and *Odaw* freshwater ecosystems depicted significance evidence of waste pollution. Similarly, most marine ecosystems in Accra are heavily polluted with waste. Massive pile-up of wastes on street corners and parks were also uncovered during the field investigation (see figs. 7.14-7.15). In all cases the presence of plastic residue is ubiquitous.

[30] Traditional name of the ecosystem
[31] Traditional name of the river

Figure 7.14: Pile-up of wastes on street corners in the AMA. Photo by Squire, 2010

Figure 7.15: Accumulation of Wastes at a Transportation hub Due to Infrequent Collection. Photo by Squire, 2010

In many instances, wastes were observed accumulated in very close proximity to human settlements, lorry parks, schools and commercial establishments. Drainage systems constructed to aid the flow of liquid wastewater have become receptacles for solid waste.

The disposal of untreated hospital wastewater in sewers and drains further triggers major concerns around ecosystem health. Certain classes of pharmaceutical and chemical pollutants are known to be bioactive even at low concentrations, resist degradation, possess several target receptors and follow complex biological pathways (Purdom *et al.,* 1994; Daughton & Ternes, 1999; Stuer-Lauridsen *et al.,* 2000). Consequently, the frequent exposure of aquatic organisms including fish, algae and bacteria to hospital wastewater with high concentrations of biomedical pollutants is likely to have adverse repercussions (Brooks *et al.,* 20003; Halling-Sorensen, 2000; Pascoe *et al.,* 2003; Wilson *et al.,* 2003). High concentrations of everyday pharmaceutical product like paraceutamol in aquatic ecosystems can have negative consequences for living organisms (Ferrari *et al.,* 2003; Henschel *et al.,* 1997; Jones *et al.,* 2002; Sanderson *et al.,* 2003; Tauxe-Wuersch *et al.,* 2005). A notable example is the feminization of male fishes in some British rivers due to exposure to low levels of oral contraceptives (Jobling *et al.,* 1998; Larson et at., 1999). Perhaps this explains the Korle Lagoon ecological tragedy, given the proximity of the ecosystem to the largest healthcare facility in Ghana.

Last but not the least, crude and unregulated burning of some classes of biomedical pollutants such as heavy metals are likely to contribute to the discharge of dangerous gases and particulates into the environment. These include poly-nuclear aromatic hydrocarbons (PAH), polychlorinated dibenzo-furans (PCDF), polychlorinated dibenzo-para-dioxins (PCDD) polychlorinated biphenyls (PCBs), hydrogen, lead, mercury, cadmium, chlorobenzenes, particulate matter and chlorophenols (Bakoglu *et al.,* 2004; Levendis *et al.,* 2001).

7.6.2 Public Health Risks

Overall, survey respondents and interviewees identified contamination of drinking water, cholera, malaria, needle-stick injuries, air pollution and flooding as major risks associated with ineffective waste management practices in the AMA (see fig. 7.6). Interestingly, less than half, (45% or 171/380) saw the possibility of biomedical pollutants contaminating drinking water sources as a major public health concern although certain classes of pollutants have been detected in drinking, ground and surface waters in some countries (*see for example,* Christensen, 1998; Schulman *et al.,* 2003; Webb *et al.,* 2003). Although scientists suggest that the likelihood of the presence of PhACs adversely affecting human health is improbable, potential impacts on embryos and foetuses remain relatively unknown (Pomati *et al.,* 2006). People with compromised immune systems and chemical sensitivities may develop resistance to antibiotics when they consume water contaminated with certain classes of BMW (Christensen, 1998; Daughton & Ternes, 1999).

In contrast, cholera and malaria were identified by all (100%) respondents as a major problem. Since the 1970's, cholera outbreaks in the AMA have affected thousands and has contributed to the loss of lives. The disease is spread through food and water contaminated by the *Vibrio Cholerae* bacteria and in its acute stage can cause severe dehydration and death within hours of being infected. In the first quarter of 2011, a total of 4,586 cases of cholera were reported in Ghana, 4,190 of such cases were reported in the entire Greater Accra region, 3,207 of which was recorded in the AMA (Daily Graphic, 2011). The 2011 cholera epidemic contributed to 64 fatalities country-wide, over half of which occurred in the Greater Accra region (Ibid, 2011).

The practice of disposing wastes into drains and sewers also provide ideal breeding environments for Anopheles mosquitoes that transmit malaria parasites. In its acute form, malaria infection can lead to anaemia in children, reduced birth weights and contribute to maternal and infant mortality (Murphy & Breman, 2001). Concerns arising out of needle stick injuries stems from open dumping of biomedical pollutants. Stakeholders assert that the general public particularly children and domestic livestock stand the most risk of infection.

Human interaction or consumption of infected livestock can be detrimental. Likewise, the use of potentially contaminated hospital wastewater as sources of irrigation coupled with, the storage of food and water in discarded biomedical waste containers raises public health concerns due to the likely presence of pathogenic microorganisms. Furthermore, flooding was also highlighted by 75% (285/380) of interviewees as a perennial problem caused by ineffective waste management practices.

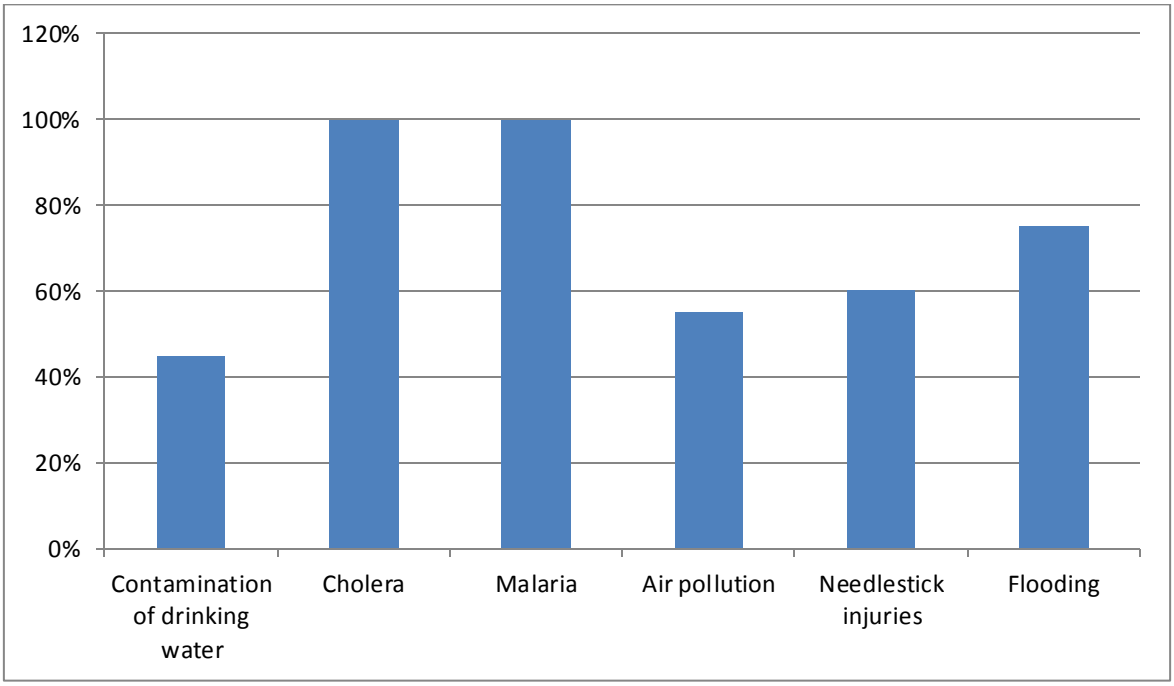

Figure 7.16: Waste-related risks identified by survey respondents.

7.7 Summary of Interview Results

As part of the research process, stakeholders representing healthcare providers, waste management service providers, members of the general public as well as local and central government officials were asked to provide their assessment of waste management in the AMA and how the current situation might be improved. During the interviewing process, interviewees were initially given the opportunity to float their own ideas as to how best the current waste management situation might be improved. Thereafter, relevant features of the FUME concept were floated to interviewees who were asked to provide their own

assessment. The results of the interviews were analyzed extensively, open-coded and dominant themes were identified. The main ideas postulated by interviewees are summarized in table 7.5.

Table 7.5: Summary of Interview results

Nature of the Problem	Possible solutions recommended by interviewees
Poor management of wastes and biomedical pollutants	Adopt an integrated approach to the management of urban wastes and biomedical pollutants Integration of scientific and traditional knowledge in waste management
Poor planning	Adopt a bottom-up approach to planning Communicative planning
Corruption	More transparency and accountability Stringent laws against corruption Improve working conditions
Population growth vs. resource constraints	Need to make the WMD more financially viable and independent Investment in waste management infrastructure Capacity building
Late payment of service charges	Effective monitoring of the AMA
Lack of awareness & education	Intense environmental education and awareness Environmental Advocacy Communication of risk issues
Ineffective regulatory frameworks	Need for effective policies Adopt a precautionary approach Adopt adaptive management principles
Lack of stakeholder consultation & public participation	Decentralization Intersectoral cooperation Co-management Citizen involvement Consultation with stakeholders
Poor working conditions	Better working conditions
Distrust of urban officials	Make the WMD autonomous from the Metropolitan Authority Hire new personnel with the skills and experience to manage the affairs of the WMD

7.8 Interpretation of Interview Results

All 25 interviewees acknowledged major deficiencies with regards to the management of wastes and biomedical pollutants in the AMA. Interviewees overwhelmingly

identified poor storage practices, low collection frequency, indiscriminate littering and open dumping as major issues. The design of containers was also seen as obstacles to effective storage of wastes. The magnitude of the problems has been identified elsewhere in this chapter (see sections 7.4.4 – 7.5.9). On the question of how the overall waste situation might be improved, several interviewees suggested the implementation of an integrated waste management model that places emphasis on reduction, recycling and composting. Interviewee 8, a healthcare provider, reiterated the need for the incorporation of local knowledge and practices in waste management. He stated:

> For many years households engaged in the reuse of materials such as bottles, cans, plastics as receptacles for storing food, water and fuel. Using dried sugarcane peels and coconut husks for smoking fish are common in many households. Food leftovers are also harvested in restaurants and local eateries and used as feed for domestic animals. What is left over is composted in the backyard. When you go to Kantamanto, (a suburb of Accra), people use discarded automobile tires as raw materials for making sandals. We have to go back to these traditional ways of managing wastes in order to save the environment like you are saying. The people have to be educated.

Stakeholders also suggested the need for portable waste management storage containers, regular collection, optimization of collection services, more government involvement and environmental education.

The issue of poor planning was highlighted by healthcare providers and was supported by all the other stakeholder groups including local and central government interviewees as a major contributing factor to the poor state of waste management in the AMA. The top-down approaches to waste management and environmental policy planning in the AMA has been dissected in sections 7.31 – 7.3.5 of this chapter. All healthcare and waste management service providers interviewed bemoaned the current top-down approach to planning and decision making as major obstacles to effective waste management. These stakeholders contend that they are rarely consulted on issues relating to waste management and authorities merely impose decisions on them. In response, local government officials claim they are not able to consult with every stakeholder due to logistical and resource

constraints. To this effect, all stakeholders called for a bottom-up approach to planning as well as the need for consensus building and dialogue in the process.

Individual and systemic corruption were also identified as a major problem by all interviewees. An interviewee from the pool of private waste management service providers accused officials of the Accra Metropolitan Authority of conniving with some service providers to defraud the system. This scheme apparently involves a process of inflating invoices for payment. In some cases, the job for which payment is made does not measure up to the amount charged, or the job was not performed at all. This information was corroborated by some informants from the Accra Metropolitan Assembly who acknowledged widespread institutional corruption in the local government system. Interviewee 14 suggested that the causes of corruption could be as a result of low wages. Greed, inequality and cultural practices were also identified by some interviewees as a major reason for the prevalence of corruption in the civil and public service institutions. Interviewees suggested several ways in which corruption might be mitigated including transparency and stringent punishment for corrupt officials. Interviewee 18 suggested that perhaps corruption can be curtailed once working conditions for civil and public servants are improved.

Constraints in human, technical and financial resources against the backdrop of rapid population growth were identified by local government interviewees as a major problem militating against the attainment of effective outcomes in waste management service delivery. Interviewee 18 attributed this phenomenon to the status of the AMA as a primate city that attracts a steady flow of temporal and permanent migrants and visitors. Interviewee 12 noted that although the population of Accra has been increasing rapidly since independence, such growth has not been accompanied by adequate investments in waste management. Resultantly, the consumption patterns of residents, migrants and visitors contribute to the generation of stupendous amounts of waste especially plastic residue which is used as a packaging material for most commodities including food and drinking water (Interviewee 18). To make matters worse, the local government is cash-strapped, relying on the central government for funding which is often not enough (interviewee 17). In order to

address this problem, local government interviewees reiterated the need to make the WMD a financially viable institution by allowing them the freedom to raise capital. Capacity building as well as a call on the central government to invest massively in waste management infrastructure and personnel was also indicated by local government stakeholders.

Interviewees drawn from the pool of private waste management service providers within the private sector expressed dissatisfaction with the local government in regards to the length of time taken to pay for services delivered. To this effect, interviewee 6 stated: *Sometimes, it takes months and even years for the AMA to pay us after we have done the job. As a result, we find it difficult to procure the necessary logistics to effectively perform our part*. The magnitude of the situation is reported to have reached crises dimensions in 2008 when the 17 members of the Environmental Service Providers Association (ESPA) threatened to suspend all services in the metropolis if the AMA fails to pay them their accumulated arrears in one week (Daily Graphic, 2008). A media report quotes an executive member of the ESPA as saying "*our creditors are chasing us, salaries for our workers are outstanding for months, while most of our vehicles have broken down due to lack of maintenance* (Ibid, 2008). In March 2011, the Metropolitan Assembly (MA) promised to clear the debts owed to private waste management service providers in weeks (Daily Graphic, 2011). To date, it remains unclear if this promise has been fulfilled.

The issue of non-payment of user fees by some residents was also highlighted by interviewee 7 as a major problem. He stated: "*Sometimes, our revenue assistants will chase consumers for fees which are sometimes not paid in months. This makes it difficult for us to get our money and acquire the necessary logistics to perform efficiently. When we are not able to retrieve our monies, we discontinue services to defaulting residents"*. It was uncovered that in some instances some residents residing in compound houses refuse to contribute toward the payment of waste management services due to high costs and poor quality of services.

The interviews and informal group discussions revealed widespread distrust, discontent and animosity on the part of residents toward the Accra Metropolitan Authority.

Ostensibly, this is due to the poor waste management service delivery in juxtaposition to fees deemed exorbitant by users. It was uncovered that in some instances some residents residing in compound houses refused to contribute toward the payment of waste management services due to high costs and poor quality of services. Many aggrieved residents engage in illegal dumping of waste. As a result of such high degrees of distrust, one of the interviewees suggested the elimination of the WMD and replacing it with an autonomous and independent agency. This view was supported by a few other key stakeholders.

Frontline personnel drawn from the pool of private waste management, healthcare providers and junior level government agencies highlighted poor working conditions as a major factor contributing to ineffective waste management practices in Accra. Some of the major issues identified include low salaries which are often left unpaid for months, employee intimidation as well as the lack of training and incentives. As a local government institution, the AMA is part of the broader civil service organization where the average worker earns less than the equivalent of US$80 per month. The situation is worse among sanitation and environmental personnel whose salary range from the equivalent of US$40-60 per month which is sometimes not paid for several months. As noted by interviewee 9: *"They don't pay us well. We have to buy our own protective gear and sometimes when we get sick we have to go to hospital and pay for it ourselves. Meanwhile, these people (the bosses) drive big big cars and they pay us nothing"*. Such concerns were echoed by many frontline personnel during the focus-group discussions. The issue of low salaries as an obstacle to effective job performance was acknowledged by several interviewees.

The lack of stakeholder consultation and public participation in waste management planning and decision making was echoed by healthcare providers and waste management service providers. Interviewees suggested the need for more intersectoral co-operation as well as direct consultation with all key stakeholders when planning and making decisions regarding waste management. This was acknowledged by informants within the local government who admitted that more can be done to bring the public on board. In an effort to

improve the situation, interviewees touted the need for citizen participation and stakeholder consultation in the planning process.

7.9 The Views of Interviewees Regarding FUME and Possible Amelioration Strategies

As part of the research, the opinions of stakeholders and policy makers with regards to existing environmental planning and management theories were solicited. All 25 (100%) interviewees expressed a positive attitude toward the use of relevant aspects of the precautionary principle including transparency, addressing uncertainty and public participation when planning and making decisions around the environment and waste management. In voicing out his support for the precautionary principle, Interviewee 11 stated:

> The overall good of the precautionary principle is what it does to the environment and you cannot put money on that; so I understand that it is an expensive proposition, but no amount of money can be put on human life, therefore; I fully support the use of the precautionary principle in environmental decisions.

Notwithstanding the overwhelming support for the precautionary principle, several overarching issues were raised. These include the issue of public acceptance, costs and modalities for implementation. Interviewee 11 pointed out that the success of the precautionary principle is dependent on how it is applied. He stated: *"People have been used to doing things in a certain way, where they have not really looked at the dangers in doing it and it has become acceptable as the norm. Therefore, the use of the precautionary principle must be in terms of bringing down information to the forefront, but not just implementing it all the way, because then the people will revolt"*. Interviewee 8 also noted that education and awareness are necessary for a successful implementation of the precautionary principle.

The emphasis on consideration of indigenous knowledge, inter-sectoral cooperation and economic viability within the ecosystem approach was also approved by all 25 (100%) interviewees. On the notion of inter-sectoral co-operation interviewee 7 noted: *"I agree that an interdisciplinary approach is very important in all spheres of life in the academic,*

cultural and traditional. People's levels of learning, people's level of experience should be brought to bear on the situation. This is why the ecosystem approach is good". Interviewee 8 justified the inclusion of local stakeholders on the basis of the interconnected nature of environmental problems by stating that, *"whatever you do has some connection to another, so you cannot separate them. The expert-driven approach doesn't work in this case, you need an interdisciplinary approach"*. Interviewee 14 further stated: *"because stakeholders will be involved in the implementation, unless they are committed and have a full understanding of the issue, it doesn't matter what you do; not including them will be useless. That must be the case even before policies are implemented"*. This sense requires an interdisciplinary approach that combines the knowledge, views and expertise of local stakeholders.

The idea of accommodating sudden changes and surprises in the management process as emblazoned within the principle of adaptive management was supported by all 25 interviewees. While adaptive management principles are often used in relation to addressing sudden changes and surprises in ecosystem functions and processes, stakeholders in the AMA want a modification of the concept to encompass functions performed by public institutions. Interviewee 11 noted: *"Any progressive person or institution has to make room for change and surprises in decision-making. You don't have to assume that that you are going to be 100% successful. When you have to take the bull by the horn you have to be willing to take risks, you have to be willing to learn through the process"*. Interviewee 21 referred to the use of adaptive planning and management in environmental decision making as having a second line of defence. He stated: *"In whatever you do, there must be that alternative or alternatives because what have been done in one community or society do not necessarily apply to another so you should have that contingency plan"*. Interviewee 13 further reiterated: *"You see, the thing is, you can only accept that you have made mistakes if you do follow-up and reassess what you have done. This is totally lacking in the system, you do it and that's it, until something terrible happens. Adaptive planning takes care of such things"*

The need for governments at all levels to devolve some authority to local communities is in line with the principles of co-management and was supported by all interviewees. However, the vast majority of interviewees (21/25) believe the central government must play a leading role in planning, regulating and managing the environment. Interviewee 2 suggested the setting up of an independent waste management agency to be run under a co-management scheme involving key stakeholders including representatives of the IC&I sectors, civil society as well as the central government and local government.

The need to communicate risk issues as well as consultation with stakeholders in the planning and decision making process as inscribed in the risk management framework within FUME, was supported by all interviewees. Risk communication was seen as a means of educating the general public by interviewee 4. In the opinion of interviewee 9, consultation with stakeholders will ensure the incorporation of local ideals in the management process.

The planning theoretical concepts of functional decentralization, communication and advocacy received tremendous approval from all stakeholders. Advocacy was seen as a tool that might aid in the public education process by most interviewees. The notion of building consensus through communicative planning was also received highly by interviewees. Decentralization was seen by some stakeholders as a way of moving the WMD from the claws of the local and central governments.

Stakeholders in the AMA overwhelmingly supported the notion of an integrated approach to waste management service delivery. In particular, stakeholders emphasized the need to hold generators of plastic wastes responsible for the cost of collection and disposal. For many interviewees the application of extended producer responsibility to manufacturers of plastic bags will ensure a careful analysis of the life-cycle of products. Some interviewees acknowledged that such a move might result in increasing cost of products but it is necessary for the prevention of pollution and degradation of the environment. Interviewees supported the idea that since wastes are not homogenous, it is necessary to apply appropriate techniques to different types of wastes in order to ensure sustainability. A list of some of the responses provided by interviewees is provided in tables 7.6

Table 7.6: The views of stakeholders regarding the FUME Concept

"People's levels of education, levels of learning, and levels of experience should all be brought to bear on the situation. This is why the ecosystem approach is good". *Interviewee 14*	"The ability to build consensus, respect other peoples' views and take them into consideration and invite others to the table, but when it is all said and done, it is how well it is put together for implementation of the common goal" -Interviewee 12	"The top-down approach simply doesn't work". We need to incorporate all thinking, mobilize all resources and bring people together to do the job" -Interviewee 20
"We should never compromise certain measures, for example the health and safety of the people. The precautionary principle is a good step towards the non-compromise position. -Interviewee 23	"Whatever you do has some connection to another, so you cannot separate them. The expert driven approach doesn't work in this case, you need an interdisciplinary approach" *Interviewee 8*	"The economic potential of ecosystems has to be realized. This will let people change their attitudes and behaviours. Interviewee 1
"There is a need for co-operation and collaboration among all sectors to make any approach work" Interviewee 2	"When it is all said and done, you must bring the public on board, you must work with them, you must have public opinion, you must do everything to bring the people on board, you must work from the grassroots Interviewee 22	"Often, the public and others involved are not aware of their responsibilities and involvement and what they should specifically because they are not included in the planning and decision making process" -Interviewee 16
"The bottom line is that you have to put the responsibility in the hands of the people because if government is seen or assembly has been seen to always shoving things through the throat of the people, you are not helping them, we want to get the people involved to some extent" -Interviewee 6	"Any progressive person or institution has to make room for change and surprises in decision making. You don't have to assume that that you are going to be a 100% successful. When you have to take the bull by the horn you have to be willing to take risks, you have to be willing to learn through the process" -Interviewee 11	"Adaptive management is a good concept. I see it as having a second line of defence" -Interviewee 8

	"Absolutely yes! I agree with the precautionary principle" -Interviewee 9	
"The overall good of the precautionary principle is what it does to the environment and you cannot put money on that, so I understand that it is an expensive preposition, but no amount of money can be put on human life, therefore, I full support the use of the precautionary principle in environmental decisions" Interviewee 11	"There is too much corruption in the system. Even though the precautionary principle sounds good, these politicians will use it as an excuse to steal from the people" Interviewee 17	"You see, the thing is, you can only accept that you have made mistakes if you do follow-up and reassess what you have done. This is totally lacking in the system, you do it and that's it, until something terrible happens" -Interviewee 13
As a doctor, my training includes the prevention of illnesses and infirmities when and where possible. I do this with or without the precautionary principle. If there is a principle, that requires me to take action to eliminate possible risks, that can materialize into real dangers, I am all for it" -Interviewee 1	"I have never heard of it but from what you are saying, it sounds like a good thing. I think our leaders must consider it". Interviewee 25	"I think implementation of the precautionary principle in environmental policy must be accompanied by proper education and training". Interviewee 14
Integrated waste management sounds like a great idea! Interviewee 9	"The precautionary principle is a good thing but you must be careful how you implement it". -Interviewee 22	We expect the metropolitan authorities to work with us since we are not isolated from the rest of the population. However, they do not consult us and yes, I haven't seen any of the manual you are talking about" -Interviewee 4

7.10 Summary of Chapter

The case study findings demonstrate that the management of urban wastes including biomedical pollutants in the AMA is in a precarious state, resulting in the magnification of risks to the environment and human health. This is due to a multiplicity of factors, chief amongst which are poor governance structures, resource constraints and a reliance on the conventional approach to waste management service delivery. A thorough discussion of the findings is the focus of attention in the next chapter.

Chapter 8

Discussion, Synthesis and Conclusion

8.1 Introduction

The case study findings analyzed in the previous chapter provides ample insights into the management of biomedical pollutants and urban wastes in the Accra Metropolitan Area. In this chapter, the theoretical implications of the findings in relation to the existing discourse on urban waste management in developing countries are assessed. The chapter also examine ways in which the current approaches to managing wastes and biomedical pollutants might be improved in line with the FUME model as well as the research findings. Additionally, the chapter discuss the policy implications and contributions of this thesis to the existing body of knowledge. Finally, directions for future research, synthesis of the thesis and final conclusions are presented in this chapter.

8.2 Discussion: Linking the Findings to the Body of Knowledge

Based on the findings it can be surmised that waste management service delivery in the AMA is emblematic of the conventional approach to service delivery which assumes a top-down and technocratic approach to waste management in the absence of effective public participation (Sinha, 1993; Soerjani, 1984). In its standard disposition, the conventional approach typically involves a system in which waste management responsibilities are legally entrusted to a local government or municipality by the central government. Operational funding is generated internally through user fees and municipal taxes, while central governments and donor agencies provide additional revenue (see for example, Ali *et al.*, 1999; Bubba & Lamba, 1991; Cointreau, 1982; Gilbert *et al.,* 1996; Gidman *et al.,* 1995; Oluwande, 1984; Van de Klunkert & Lardinois, 1994). Within the conventional scheme of service delivery, emphasis is placed on the collection and disposal of wastes, with very little attention paid to other aspects of the management process such as; minimization, recycling

and composting (Cointreau, 1982). In relation to the case study findings, the following linkages can be established:

- Lack of citizen participation and stakeholder consultation in the planning and decision-making process
- Operational funding is generated internally with the central government and donor agencies providing extra support
- The emphasis is on the collection and disposal of wastes with little to no attention given to other management aspects such as minimization, recycling and composting
- No separation of different types of waste – Comingling of regular wastes and biomedical pollutants

In regards to the lack of public participation, it emerged during the field investigation that most public documents pertaining to the management of wastes and the environment were designed by 'committees of experts' or 'intersectoral technical teams' appointed by the central government. Representatives of key stakeholder groups interviewed during the field investigation alluded to not being consulted or invited to participate in waste management planning processes. Such top-down approaches to planning and decision making represents a central feature of the conventional approach and has been critiqued as wholly ineffective and unable to cope with addressing urban waste management challenges (Furedy, 1995; Sinha, 1993; Soerjani, 1984). The situation in the AMA attests to this fact. In particular, the lack of public participation contravenes the ideals of good governance and has been the subject of much discussion (see for example, Attahi, 1999; Kironde, 1999, Onibokun & Kumuyi, 1999; Swilling & Hutt, 1999). The absence of effective public participation contributes to a general lack of awareness in regards to waste management policies and regulations. This is characteristic of waste management challenges in developing countries (Ali & Saywell, 1995; Sinha, 1993; Soerani, 1984).

Another point of convergence in regards to the case study findings and the existing body of knowledge is the revelation that funding for waste management is derived mainly

from user fees, service charges, taxes and external sources. This represents a major hallmark of the conventional approach to waste management service delivery in developing countries (see for example, Ali *et al.,* 1999; Bubba & Lamba, 1991; Cointreau, 1982; Gilbert *et al.,* 1996; Gidman *et al.,* 1995; Oluwande, 1984; Van de Klunkert & Lardinois, 1994). In the AMA, internally generated revenue from sources such as property rates, rents businesses registration licenses accounts for 60% of total funding the bulk of which are allocated toward waste management service delivery. This is symmetrical of the situation in many developing countries where municipalities reportedly expend approximately 30-50% of operating budgets on waste management (Arlosoroff & Bartone, 1987).

Perhaps central to the nexus between the case study findings and the conventional approach is the emphasis on waste collection and disposal with very little attention paid to other aspects of the management process such as treatment, minimization and recovery. In the AMA the principal method of managing urban wastes including biomedical pollutants generated in healthcare facilities is predicated on a 'collect and dispose' approach. Even within this arrangement, the frequency of collection was found to be very poor in many areas of the metropolis and the main disposal method was by means of open-dumping. As demonstrated in the findings, such operational deficiencies illuminate major concerns around environmental and human health. Some of the risks include the contamination of aquatic ecosystems, perennial flooding, cholera, needle stick injuries, malaria and environmental degradation. Such concerns are widespread in many developing countries and are believed to be contributing factors to waste-related diseases such as cholera, paratyphoid and shigellosis (see for example, Christiansson, 1993; Hardoy, Mitlin and Satterwaith, 200; Izeogu, 1989; Mosha, 1990; Mwanthi *et al.,* 1997; Ohnesgoron, 1993; Rakodi; 1997; Stren and Kjellberg-Bell; Stren and White, 1989; Wekete, 1994; WHO, 2010). A conspicuous gap however, is the risks posed by the ineffective management of biomedical pollutants generated in the course of healthcare activities. The revelation that some urban farmers use hospital wastewater as irrigation sources for fresh produce adds a measure of uncertainty to the risks. This is due to a general lack of information regarding the risks to human health as a result of the

consumption of produce irrigated with hospital wastewater. Nonetheless, the ineffective management of urban wastes and biomedical pollutants has the probability of contributing to an incessant cycle of cause and effect relationships (see fig. 8.1).

Figure 8.1: Incessant cycle of cause and effect relationships arising out ineffective waste management practices. Developed by Squire, 2011

The mismanagement of infectious and hazardous biomedical pollutants generated in the course of healthcare activities adds depth to such concerns. In view of its infectious and toxic characteristics, the effective management of biomedical pollutants is trumpeted in the literature as the key to mitigating environmental and human health risks (Burke, 1994; Diaz, et al, 2005; Klangsin & Harding, 1998; Pruss *et al.* 1999; Socunya, Matias & Lapid, 1997; Diaz *et al.*, 2005; Tamplin *et al.* 2005; WHO, 2007). Effective management approaches outlined in the literature include safe handling, segregation, treatment, storage, collection and safe disposal. Yet, as demonstrated in the findings there are no effective arrangements for managing biomedical wastes at the systemic level. In addition, none of the healthcare facilities surveyed in the AMA had proper procedures for managing biomedical pollutants. Resultantly, the management of biomedical wastes generated in the course of healthcare activities are facilitated within the same prism as regular urban wastes. This practice is fairly common in many developing countries and has received much attention (see for example, Alagoz & Kocasoy, 2008 Al-Khatib *et al.*, 2009;; Askarian *et al.*, 2004; Bassey *et al.*, 2006;

Da Silva *et al.,* 2005; Gupta & Boojh, 2008; Hassan *et al.,* 2008; Mbongwe, *et al.,* 2008; Mato & Kaseva, 1997; Nemathaga *et al.,* 2007).

The findings revealed that the lack of human, technical and financial resources accounts for one of the principal reasons militating against the effective management of wastes including biomedical pollutants. According to the stakeholders representing private sector waste management service providers, the lack of resources makes it difficult to pay their personnel and acquire the necessary logistics and equipment necessary for facilitating their duties in an efficient manner. The situation is aggravated by the inability of the WMD to pay private contractors on time, a situation the Accra Metropolitan officials blame on the lack of financial resources. Metropolitan officials also assert that the lack of financial resources accounts for the reason why there is neither a single sanitary landfill nor a functioning incinerator in the metropolis. Such challenges can hardly be described as peculiar to the AMA since it has been reported elsewhere in other developing countries (see for example, Alam *et al.,* 2008; Ali *et al.,* 1999; Bubba & Lamba, 1991; Gilbert *et al.,* 1996; Van de Klunkert & Lardinois, 1994; Kironde, 1999; Korfamcher, 1999; Mosha, 1990; Moreno *et al.,* 1999; Pfammatter & Schertneib, 1996; Onibokun & Kumuyi 1999; Werlin, 1995). In an attempt to offset the challenges posed by the lack of financial resources, urban authorities in many developing countries including the AMA introduced cost recovery measures such as user fees and municipal taxes (Attahi, 1999; Boakye-Yiadom, Jr., 1997; Kironde, 1999; Onibokun & Kumuyi, 1999; Porter *et al.,* 1997). However as illustrated in the case study findings, the introduction of user fees has not done much to improve the waste management situation. The situation is more acute in middle and low income areas of the AMA, bringing to question the issue of equity.

Inequitable delivery of services coupled with the disproportionate location of waste pollution sources is a common phenomenon in many developing countries (Cointreau, 1982; Blight & Mbande, 1998; Wang & Nie, 2001; Werlin, 1994; Wilson & Nair, 1992). This was found to be the case in the AMA where formal waste management service delivery was found to be concentrated in high income areas of the metropolis where residents are likely to

pay for services. In contrast, middle and low income areas tend to have limited access to formal service delivery and rely heavily on the informal sector. The research also uncovered the presence of several waste dumps in middle and poor income areas more so than in upper class areas.

Corruption was identified by stakeholders as one of the key factors undermining effective waste management service delivery in the AMA. It emerged during the field investigation that some private waste management service providers engage in corrupt activities by adding water to waste to increase its weight. Such acts occurred when private contractors were paid by the AMA according to the tonnage of wastes collected for disposal. Another revelation of corruption came in the form of some private waste management service providers presenting over-inflated invoices to the Accra Metropolitan Authority for payment in connivance with scrupulous agents within the local government. Such institutionalized forms of corruption are widespread in many developing countries and has been shown to have a stifling effect on revenue collection and cost-recovery (Anku, 1997; Annor and Schweizer, 1996; Porter *et al.*, 1997; Post, 1999). According to information derived from the literature corruption in developing countries is enabled by a number of factors including inequality and poverty. The situation in the AMA aptly demonstrates the role of poverty in enabling corruption. As a local government institution, the AMA is part of the broader civil service organization where the average worker earns less than the equivalent of US$80 per month. The situation is worse among sanitation and environmental personnel whose salary range from the equivalent of US$40-60 per month which is sometimes not paid for several months. The situation is no different in the private sector where personnel highlighted low wages and poor working conditions as a major problem. Under such conditions, corruption has become a necessary survival mechanism.

The role of the private sector in ensuring effective outcomes in waste management service delivery is challenged by the findings. Private sector participation in waste management service delivery has been trumpeted in recent years as the key to ensuring effective outcomes (Bartone, *et al.*, 1991; Batley, 1996; Kironde, 1999; Majani, 2000;

Obirih-Opareh & Post, 2002; Ogu, 2000). This is predicated on a premise that views ownership as central to better performance (Abu Shair, 1997; Davies, 1981; Hodge, 2000). Proponents view the private sector as having as the key to ensuring low cost, efficiency, competition as well as access to funds for capital investment (Bartone, Bernstein & Wright, 1990; Blais & Dion, 1992; Diaz *et al.*, 2005; Jackson, 1982). However, as demonstrated in the findings, private sector involvement in waste management service delivery has not lived to expectations. Rather, the private sector is viewed by most interviewees as part of the problem. The private sector was found to be ill-equipped and lacked the necessary human, technical and financial resources needed for better performance. Some private contractors were also found to have become part of the problem by engaging in corrupt activities.

The informal sector was found to play a prominent role in the delivery of waste management services in the AMA. In underserviced areas such as slums and low income neighbourhoods of the metropolis, the services of informal sector waste collectors are highly utilized. The research revealed a widespread practice of informal sector waste carriers known in the local parlance as 'kaya-boorla' operating by means of donkey carts, wheelbarrows head pans and cane baskets for the collection of urban wastes. A significant presence of informal sector workers was also observed engaging in the recovery of wastes at the authorized dumpsite in the AMA. This is a common practice in many developing countries where informal sector activities evolve around street sweeping, waste collection, recovery and disposal (Adeyemi, Olurunfemi & Adewoye, 2001; Beukering *et al.*, 1999; Korfmacher, 1997; Medina, 1997; Mendoza 1997; Nzeadibe, 2009). The scavenging of biomedical wastes for recoverable materials was also observed in the AMA. Similar practices have been reported in some developing countries (Gupta & Boojh, 2006; Hassan *et al.*, 2008). This has several implications for the environment and public health. For example, wastes with high contents of heavy metals such as; mercury in dental amalgam, lead and silver produced in dental X-rays are known to have neurotoxic and nephrotoxic effects on human health by interfering with metabolic processes (Hedge *et al.* 2007; Perben, 2004). Exposure to certain types of cytotoxic drugs can also stop or kill the growth of certain living cells (Pruss *et al.*,

1999). Some chemical residues contained in biomedical pollutants can affect the liver, blood and kidneys and nerve system in the human body (Griffin, 1990). Thus, while the role of the informal sector can be said to be prominent, their potential to spread infection and cause contamination cannot be ignored.

Political instability did not emerge as a major problem militating against the delivery of waste management services in the AMA although it is highlighted in the literature as a major contributing factor to ineffective waste management in many developing countries (Ali *et al.,* 1999; Bubba & Lumba, 1991; Onibokun & Kumuyi, 1999). In Mogadishu and Kabul, years of civil war contributed to the accumulation of refuse on street corners for significant periods of time (Amanullah, 1995; Barise, 2001). It must be emphasized however, that although this is not the case in the AMA, the reliance on the central government and external agencies for funding makes the decision-making process prone to political interference and influence peddling. Concerns regarding influence peddling and political interference have been raised in the literature (*see for example,* Ali *et al.,* 1999; Bubba & Lamba, 1991; Leduka, 1991; Musandu-Nyamayaro, 1991; Mwafongo, 1991). In the AMA, the structure of the urban governance system in which the Metropolitan Chief Executive (MCE) is appointed by the president rather than elected by the people lends credence to such concerns. Acts of intrusion may involve the appointment of unqualified political cronies and loyalists with no relevant qualification and expertise to sensitive positions. The appointment of personnel based on political expediency has a high proclivity to allow bias and subjectivity to permeate the decision-making process. Under such conditions, unpopular albeit necessary decisions may be differed or completely abandoned. A change in the political administration of the country is also likely to bring to a halt existing waste management plans since new regimes are notorious for debunking and abandoning policies initiated by their predecessors. This is not without precedent in Ghana, a classic example being the abandoning of a sewerage system in the AMA after the 1966 coup that overthrew the First Republic. In view of this, there is a need to have an independent and impartial waste management system in place that

allows for the continuation of policies after a regime change. Currently, there is nothing to this effect in the AMA and Ghana in general.

Similarly, although urbanization is mentioned in the literature as a factor contributing to waste management challenges in developing countries, this did not emerge in any significant way as an issue in the AMA. However, this does not indicate that urbanization has no role in the current situation. Waste is the by-product of human activities and as such, the rapid growth of Accra's urban population over the years can be said to have some implications for waste management. The AMA accounts for 25% of Ghana's total urban population and has an estimated population growth rate of between 3.36 – 4.2 % annually (GSS, 2000; World Bank, 2006). As a primate city, the AMA is the nerve centre for socio-economic as well as political activities in Ghana and as such, attracts thousands of visitors on a regular basis. The consumption patterns of urban dwellers as well as regular commuters contribute to the generation of wastes, especially, plastic bags that are commonly used as packaging materials. However, based on the findings, the argument can be made that the core of the problem is not the volume of wastes generated but rather, the inability of authorities to carry out effective management practices.

Thus, multiple aspects of the case study findings correspond with the theoretical debates surrounding the management of wastes in developing countries, the extent of which has been analyzed thoroughly in this section. Ameliorating the current situation clearly necessitates a paradigm shift. The next section examines strategies for improving the waste management situation in the AMA based on the findings.

8.3 Praxis: Addressing the Waste Management Challenges in the AMA with the FUME Model

At the crux of the waste management challenges facing the AMA are issues relating to poor governance, ineffective regulatory arrangements, failure of conventional approach, resource constraints, technological limitations and lack of awareness (see table 8.1). The discussion in this section focuses on ways in which the challenges might be addressed within these constraints.

Table 8.1: Summary of the problem, effects, proposed amelioration strategies and theoretical basis

Nature of the Problem as observed in the AMA	Effects as described in the thesis	Proposed way forward based on research findings	Theoretical Basis (FUME)
Ineffective Governance	▪ Lack of transparency & accountability ▪ Corruption ▪ Eroded public confidence ▪ Lack of public participation and stakeholder consultation	▪ Increase public participation ▪ Trust building ▪ Stakeholder consultation ▪ Co-management	▪ Precautionary Principle ▪ Ecosystem Approach ▪ Co-Management ▪ Adaptive Management
Feckless regulatory arrangements	▪ Failed policies ▪ Failure to address uncertainty ▪ Non-compliance of regulations	▪ Overhaul of existing regulatory arrangements ▪ Address uncertainty	▪ Precautionary Principle
Failure of the conventional approach	▪ No separate treatment, collection and disposal of biomedical pollutants ▪ No meaningful minimization, recovery, recycling and composting efforts	▪ -Consideration of indigenous knowledge ▪ -Selection of relevant techniques in the waste management process ▪ -Consideration of socio-economic and political factors	▪ Integrated Waste Management Approach
Technological Limitations	▪ Open dumping ▪ Crude burning ▪ Environmental & public health risks	▪ Construction and acquisition of relevant technologies	▪ Integrated Waste Management
Resource constraints	▪ Inability to procure logistics, vehicles and equipment	▪ Make the system economically viable	▪ Ecosystem Approach
Lack of Public Awareness	▪ Indiscriminate dumping ▪ Narrow view of waste management ▪ No consideration of biomedical pollutants	▪ Environmental education ▪ Risk communication ▪ Advocacy planning	▪ Advocacy Planning ▪ Environmental Risk Management

8.4 Addressing the Governance Issue

As demonstrated in this thesis, good environmental governance in relation to waste management service delivery is a major issue in the AMA. There are no effective coordination among various actors involved in the planning and delivery of waste management services. In addition, public participation is virtually non-existent and many key stakeholders are excluded in the planning and decision-making processes. Effectively, the top-down approach has created a parallel system of self-help with the informal sector providing services in high density low income areas while upper class areas are serviced mainly by the private formal sector. The absence of public participation also makes planning and decision-making processes devoid of transparency, probity and accountability. The lack of transparency contributes to the design of intervention strategies that do not reflect the problem. A classic example is the idea of addressing the waste management challenges through a waste-to-energy (WTE) program. This was an idea conceived in the absence of ample feasibility studies to determine if WTE program is in fact what is needed in the AMA. Eventually, the project had to be abandoned after the funder concluded that the high volumes of organic materials in the composition of wastes make a WTE project unfeasible. In addition to this, WTE programs are expensive and contribute to the discharge of chemicals, residual ash and heavy metals, which would require effective management. A transparent planning and decision-making process might have revealed such basic flaws. The lack of public participation contravenes the ideals of good governance which is predicated on power-sharing, inclusiveness, respect, tolerance and interaction among individuals and institutions within the public, private and informal sectors (see for example, Hempel, 1990; Kotze, 2008; Nzomo, 1994; Owiti & Kibwana, 1994; Swilling, 1997: p. 5; Young, 1996). This has resulted in a high level of distrust toward the local government and has effectively eroded public confidence in the system. Compounding the situation further is the issue of corruption, which was found to be prevalent in both the public and private realms of waste management service delivery in the AMA. Any step toward ameliorating the waste management situation in the AMA must address the issue of governance. Based on the research findings trust building,

and public participation is recommended as the key to improving the governance situation in the AMA.

8.4.1 Building Trust

Trust building is essential to restoring public confidence which was found to be eroded due to poor delivery of waste management services as well as the lack of public participation in planning and decision-making processes. In pursuit of the objectives of building trust, several steps can be taken. First, the central government can move toward a total transformation of the Waste Management Department (WMD) by removing it from the local government and setting it up as an independent agency. This recommendation is not without precedent in Ghana. In the aftermath of the Earth Conference on the Environment and Development, the then Environmental Protection Council (EPC) was reconstituted and renamed the Environmental Protection Agency (EPA). The new EPA was vested with the responsibility of enforcing, monitoring and controlling environmental quality in Ghana. Currently, the EPA is one of the most respected agencies in the country and has been instrumental in publishing some useful guidelines for waste management. These include: The Manual for the Preparation of District Waste Management Plans in Ghana; Guidelines for the Management of HealthCare and Veterinary Waste in Ghana and the Ghana Landfill Guidelines. The central government is seen as ideal for spearheading the trust building exercise for several reasons. First, as demonstrated in the thesis, the local government is ill-equipped and lack the most basic institutional capacities to facilitate effective self-transformation. Secondly, the high levels of distrust held by stakeholders toward the local government make self-transformation an adversative process. Thirdly, the central government has the resources and the means to facilitate meaningful change more so than the local government.

As part of the trust-building exercise several key steps can be undertaken including a co-management approach. One of the fundamental premises underlying the co-management approach entails the devolution of authority and the sharing of power, ideas and vision between governments at all levels as well as between local actors (Persoon & Van Est, 1999;

Misra & Kant, 2004; Timko & Satterfield, 2008). The co-management approach strives toward good governance by advocating for the equitable treatment of all stakeholders (Armitage *et al.*, 2007; Fisher & Jackson, 1998). In the implementation of the co-management approach, this thesis recommends that the affairs of the WMD are overseen by a board of directors comprising of stakeholders within the public, private and non-governmental sectors. Each member of the board may swear an oath to be independent, impartial and objective in their deliberations. The board of directors should be directly responsible for hiring an executive director to run the daily affairs of the WMD. In order to guard against ineffectiveness and reward excellence, the executive director must be retained on a contract basis for up to two years, subject to renewal based on performance in order to ensure accountability. Under the current system, there is inadequate accountability and officials continue to occupy their positions even though the waste management situation is worsening consistently. The co-management approach must also involve the informal sector who were found to play a prominent yet often ignored role in the AMA. Community involvement must be the cornerstone of the waste management planning and decision-making under the reconstituted WMD. Private sector representation may involve generators of biomedical pollutants including all healthcare facilities, the general public as well as stakeholders within other IC&I sectors. Informal sector participation is also deemed crucial given the prominent role they play in waste management service delivery. Participation by non-governmental organizations in the planning process is also seen as vital to addressing the waste management challenges facing the AMA. Currently, the role of NGO's in the management of wastes is negligible. These various stakeholders may be invited by decision-makers to participate and share ideas in public deliberation forums. Invitations can be sent out via mass mediated messages such as press releases, radio broadcasts and television announcements. Decision-makers may also take advantage of social media such as 'facebook' and 'twitter' to invite stakeholders to participate. This premise aligns with one of the key tenets of the ecosystem approach that suggests the need to consider indigenous

knowledge, practices, skills and expertise when planning and making decisions regarding the environment (Margerum, 1999; Margerum & Born, 1995; Szaro, 1998).

A cursory scan of the literature suggests that the co-management approach to environmental management is not a nascent concept and can be considered as old as human civilization (Borrini-Feyerabend *et al.,* 2001). In recent decades, the concept of co-management has gained significant traction among non-governmental organizations (NGOs), international aid organizations, governments and community actors in many developing countries (Mbolo, 2007; Persoon & Est, 2003). In Bangalore, India the implementation of a co-management approach involving the public, private and civil society has reportedly brought about a degree of success in the urban governance process (Kehle *et al.*, 2008). The Brazilian cities of Curitiba and Porto Alegre also have an elaborate co-management system that has ensured the effective management of wastes (Bortoleto & Hanaki, 2007; Hill, 2004; Rabinovitch & Leiman, 2004).

8.4.2 Public Participation and Stakeholder Consultation

Public participation and consultation with stakeholders are cardinal features of many environmental management tools including the precautionary principle, ecosystem approach, adaptive management, communicative planning, advocacy planning, risk management and integrated waste management. Public participation is imperative in good governance and helps to ensure a legitimate relationship between civil society and the state (Masaki, 1997), allowing for the harnessing social capital as well as the development of negotiation and organizational skills (Plummer, 2002). In Ghana, both the National Environmental Policy (ESP) as well as the Environmental Sanitation Policy (ESP) has tenets that emphasize the need for public participation, although this is not systematically implemented in any meaningful way. Similarly, consultation with stakeholders is highlighted in the Manual for the Preparation of District Waste Management Plans as a key strategic area. Therefore, there exists a legal basis for incorporating public participation and stakeholder consultation in waste management planning and decision-making processes. Based on the research findings, the recommendation being put forward in this thesis is one where the central government

enforces the public participation and stakeholder consultation clauses of the NEP and ESP. A fundamental step will be public consultation and deliberation forums where ordinary citizens and other stakeholders can participate and share ideas relating to waste management. Invitations can be sent out via mass mediated messages such as press releases, radio broadcasts and television announcements. Policy-makers can also take advantage of social media sites such as 'facebook' and 'twitter' to encourage and promote public participation.

The role of public consultation and deliberation forums in environmental governance has been tested to much success in Porto Alegre, the capital city of the Brazilian state of Rio Grande do Sul. Since 1989, responsibilities for allocating the urban budget have been undertaken jointly by both citizens and the local government (Bortoleto & Hanaki, 2007). This approach to governance has contributed to major improvements in the provision of urban services in Porto Alegre, effectively reversing the traditional top-down methods that characterize public administration in most Brazilian cities. Giving an account of the participatory process in Porto Alegre, Menegat (2000) states:

> The process of discussion and decision making follows an annual cycle of two main stages: first defining priorities and proposals for public spending in plenary assemblies in which all citizens can participate; and second, drawing up the budget proposal and expenditure plan, in which the priorities and proposals adopted by the citizens should be sufficiently developed for submission to the state legislature as the municipal budget. The budget proposal and expenditure plan should also be technically sound enough to be converted into an expenditure plan detailing the works and services to be undertaken by municipal secretariats and departments. The whole process is overseen by the municipal government and representatives elected through the participatory budgeting process namely, the participatory budgeting council and the forums of districts and sectoral delegates.

The citizen oriented approach to governance in Porto Alegre has reportedly contributed to meaningful improvements in the management of wastes in the city. This approach can be adopted in the AMA albeit with modifications that reflects existing realities.

It is worth emphasizing that while generally public participation and consultation can generally be said to be vital for good governance, one must be cognizant of the need to

address subjectivity and bias in the process. Hempel (1996: p. 53) had noted that: "in elevating an environmental condition to the status of a problem, scientists, policy makers, and ordinary citizens typically construct their diagnosis or definitions on a foundation of preconceptions and predispositions that direct their attention to particular factors of causation, change and response". This statement underscores the possibility of subjectivity being injected in the participation process due to multiple stakeholders having divergent views (Bowonder, 1984; Feijoo & Momo, 1991; Hackett, 1993). Theoretically, the communicative planning model provides a platform for building consensus between multiple stakeholders with divergent views. Healey (1996: p. 176) has noted that within the communicative model, "rather than providing technocratic leadership, the planner is an experiential learner, at most providing information to participants but primarily being sensitive to points of convergence". As part of the communicative planning process in the AMA, the central government in consultation with metropolitan officials and other stakeholders can organize a series of workshops aimed at eliciting the views of the general public. This approach offers a sharp contrast to the rational comprehensive model which assumes a top-down and technocratic disposition. In applying the communicative model to planning, there can be a series of workshops facilitated by the central government.

8.5 Addressing Regulatory Gaps

The research uncovered that regulatory instruments pertaining to waste management in the AMA are vague, lack comprehensiveness and on most accounts feckless. There are no effective frameworks for the management of biomedical pollutants from healthcare activities. The NEAP, NEP and ESP also make vague references to the issue of waste management, particularly, biomedical pollutants generated during the course of healthcare activities. In addition, although the NEP and ESP allude to the need for public participation and stakeholder consultation in environmental management, such directives are not implemented in any meaningful way. Such gaps contribute to the current state of precariousness characterizing the management urban wastes including biomedical pollutants generated during the course of healthcare activities. Any meaningful attempt at improving the waste

management situation in the AMA must therefore aim at addressing the gaps in existing policy.

The precautionary principle is one of the few international frameworks that regulate the management of hazardous wastes including biomedical pollutants and is also a fundamental tenet underlying the ESP of Ghana. However, the research uncovered that the implementation of the precautionary principle in waste management planning and decision-making in the AMA is negligible. Authorities tend to take a reactionary approach, often acting when a problem reaches crisis dimensions. The recommendation being put forward in this thesis is one where decision makers, specifically the central government apply the precautionary principle to addressing risks to the environment and public health as stipulated in the ESP. As a decision-making tool, the precautionary principle emphases the need to implement effective intervention strategies to mitigate environmental and human health risks in the absence of scientific certainty (defur & Kaszuba, 2002; Jordan & O'Riordan, 1999; Kriebel *et al.,* 2001; McGarvin, 2003). A precautionary approach is necessary for dealing with the high degrees of uncertainty characterizing the risks posed by biomedical pollutants to the environment public health. A case in point is the uncertainty surrounding the risks posed to public health as a result of the use of hospital wastewater in urban agriculture. Additionally, the emphasis on public participation and transparency are seen as ideal tools for the linking isolated forms of social capital and networking across a variety of sectors, classes, ethnicities, groups and neighbourhoods. This would require a thorough review, overhaul and strict enforcement of regulatory frameworks. In other words, there is a need for enforceable policies that address the management of biomedical pollutants in no uncertain terms, given its status as a specialized waste. As part of these efforts, mandatory training for all stakeholders involved in the production and handling of biomedical pollutants is highly recommended. The emphasis on enforcement and training are in line with standard procedures outlined in the literature on biomedical waste management (Chang, 1995; Jang, 2006; Kizlary *et al.,* 2005; Lee & Huffman, 1996; Miyazaki & Une, 2005; Muhlich *et al.*, 2003). Although these approaches have been shown to be effective in many developed

countries, it is unclear how it might work in the AMA. Therefore there is a need for careful consideration of a host of factors including costs, equity, effectiveness, ease of implementation, compliance, enforcement, monitoring, political viability, socio-economic and ecological impacts (see for example, Baron & Ng, 1996; Falconer, 1998; Patton & Sawicki, 1993). Based on the research findings, the following questions are deemed pertinent and worthy of consideration by decision makers in the AMA.

- What is the cost involved in planning, developing and implementing policies related to the management of urban wastes including biomedical pollutants?
- How might such costs be borne and by whom?
- Are strategies cost-effective?
- How effective is the policy?
- How likely are selected policies to improve the lives of the poor and vulnerable groups in society in terms of health, service delivery, participation and empowerment?
- How are selected policies likely to protect the environment and human health?
- Do selected strategies have the capacity to adapt to changes in socio-economic, political and ecological conditions if need be?
- Are strategies cost-effective?
- Do strategies include the need to address uncertainty?
- Are strategies reflective of the ideas, needs and capacities of a broad range of stakeholders?
- Do strategies include an integrated approach to waste management?

Generally, the cost-benefit analysis of implementing a particular policy is crucial at all levels of the planning and decision making process. Given the problem of resource constraints uncovered in the AMA, the implementation of a policy that would require enormous financial investments may be untenable. Effectiveness as a policy criterion therefore serves the purpose of determining the extent at which proposed policies are likely

to meet stated objectives. A feckless policy is most likely to fail, resulting in the waste of human, technical and financial resources. In other words, a policy that provides no feasible means of implementation at the local level due to the absence of operating resources can result in failure. This is the situation in the AMA where waste management policies have largely failed. Equity considerations are intended to ensure that waste management service delivery is extended to the poor and vulnerable sections of society. Currently, this was not found to be the case.

In order to assess the efficacy of regulatory arrangements, there is a need for on-going monitoring of policies. The monitoring process may involve all stakeholders including the general public, industries, institutions and commercial establishments. Thus, a grassroots or people-centred monitoring process is highly recommended. The mass media can play a vital role in this regard through the dissemination of information. The appointment of a waste management regulator or ombudsperson by the central government is seen as another viable strategy for monitoring waste management policies.

8.6 Addressing Management Challenges: From the Conventional Approach to an Integrated Mode of Service Delivery

This thesis posits that a shift from the conventional approach to an integrated mode of service delivery is necessary for addressing the waste management challenges facing the AMA. As demonstrated in the case study findings, the reliance on the conventional approach to waste management service delivery in the AMA has failed miserably, the extent of which has been documented extensively in the previous chapter. The integrated approach lays emphasis on the selection of suitable strategies for managing different types of wastes in consideration of socio-economic, political and environmental implications (Tchobanoglous *et al.*, 1993). In contrast, the conventional approach assumes a 'collect and dispose' while neglecting other management approaches such as; minimization, recycling and composting. This unsustainable approach exerts significant amount of pressure on the environment and potentially, public health.

8.6.1 Improving the Management of Regular Urban Wastes

In terms of the management of regular wastes, the recommendation being put forward is one where decision-makers consider other aspects of the management process mainly, composting. The intention here is not to negate the importance of minimization, reusing and recycling. Rather, it is meant to facilitate a sense of pragmatism in the amelioration of waste management practices in the AMA. Minimization and reusing was found to be already taking place albeit informally in the AMA. The reuse of old automobile tires, broken bottles and unwanted containers for the storage food, water and fuel are prime examples. Recycling on the other hand, typically involves making the transformation of waste into a useful product by means of chemical, biological and physical processes. This usually necessitates demand for high energy input as well as significant capital investments which are lacking in the AMA. Under such conditions, composting becomes a viable management strategy that can be undertaken relatively cheaply and this is why: A significant volume of the wastes generated in the AMA consist of putrescible organic matter, a fact that has been by cited by external donors as why a WTE program is unfeasible (Interviewee 11). Additionally, the research revealed that there have been several failed attempts at incorporating composting as part of a broader waste management strategy. The construction of the Teshie-Nungua Composting Plant in the late 1970s was meant to processing of organic matter into fertilizer for use in peri-urban agriculture. However, mismanagement coupled with a host of socio-economic challenges led to the closure of the plant by the Ministry of Environment in 2010. Another example is the Ashiedu Keteke Composting Plant that was commissioned in 1997 with the purpose of transforming organic wastes into compost. Although both initiatives failed, it demonstrates an entry point at which composting can be incorporated as part of an integrated waste management system in the AMA. However, in order to make composting a viable process therefore, this thesis suggests a strong partnership between the public and private sectors. The public sector role can be in the form of support to private sector businesses in the form of tax breaks and rebates. Similarly, both the central and local governments can issue directives to their institutions to use locally produced compost for horticultural

purposes. The idea of using incentives in environmental management is enshrined in the NEP of Ghana and therefore implementing it will mean executing the law. Thus, in addition to ensuring the diversion of wastes from dumps, composting is seen as a viable job creation strategy.

In order to address the issue of poor storage, this thesis recommends that the local government take steps to replace the awkwardly designed centralized storage containers that were found to be contributing to littering. The WMD can provide portable storage containers in all public spaces, schools, market places and lorry parks. A direct telephone line to the WMD can be provided in close proximity to the bins so users can call to report problems such as non-collection and accumulation. This provides a relatively easy way to build social capital, trust and tie performance to accountability. However, there is the potential of making matters worse if calls placed by the general public are not answered by authorities. Therefore, it is essential that the newly constituted WMD act in ways that do not put public confidence in jeopardy. Addressing the problem of unsafe storage is thus seen as a move toward improving the general waste management situation in the AMA.

In terms of the challenges associated with infrequent collection, the WMD can rectify the situation by ensuring that private service providers willing to be considered for waste collection are fully equipped. The WMD must maintain its supervisory role but must be overseen by an independent waste regulator appointed by the central government. The WMD can also have on standby, waste collection vehicles in situations where a private contractor fails to deliver for any reason. The payment of private service providers must be tied to performance. This will assist in restoring public confidence which was found to be eroded as a result of non-performance by both the public and private sectors.

8.6.2 Improving the Management of Biomedical Pollutants

The current practice of collecting and disposing of biomedical pollutants as part of the broader scheme of urban waste management is highly problematic given the risks posed to the environment and public health. Although the *Guidelines for the Management of HealthCare and Veterinary Waste in Ghana* developed by the EPA outline specific steps that

can be followed, this is not adhered to in most parts. The recommendation being put forward in this thesis is one centred on source separation as well as safe handling, storage, collection, transportation and disposal practices. Source separation is a vital aspect of integrated waste management that ensures that hazardous residue such as biomedical pollutants are segregated and treated prior to disposal. As part of the strategy, the WMD may require all generators of biomedical pollutants to practice effective source-separation. In terms of treatment, standard procedures outlined in the literature include microwave irradiation, steam autoclaving, chemical disinfection, encapsulation with immobilizing agents and incineration (CCME, 1992; Pruss *et al.*, 1999). The central government may require all generators of biomedical pollutants in the AMA to have access to such treatment technologies at all times as part of a broader regulatory process. The central government may also require all biomedical waste generators to register with the WMD for the collection, treatment and disposal of biomedical pollutants. Under the current system, only a handful of generators have access to specialized collection services. Private waste management service providers willing to be considered for the collection, treatment and disposal of hazardous wastes including biomedical pollutants must demonstrate the capability to provide training and protective gear for their staff. Such companies must be required by the WMD to have special vehicles for transporting hazardous materials. Generators must also be required to have internal guidelines aimed at ensuring safe handling, storage, treatment and safe disposal practices in accordance with standard procedures outlined by the WMD. In order to guard against non-compliance, there is a need for stringent enforcement procedures. Here the role of an independent waste regulator is deemed paramount. Generators who fail to comply with directives issued by the WMD must be held legally liable and subjected to criminal prosecution. This may guard against complacency and non-compliance with regulations. Operators of waste dumps must also be required to make special provisions for the disposal of treated biomedical pollutants. These might include the designation of a part of the dump specifically for the purpose of burying treated biomedical pollutants. Both the AMA and the WMD can ensure that such directives are being followed by sending out field inspectors to the dumps on a regular basis.

8.7 Addressing Technological Limitations

As depicted in the findings, there is currently not a single functioning municipal incineration technology, sanitary landfill or a wastewater treatment facility in the entire AMA. These are basic infrastructures required for safe and effective waste management practices. Under such conditions, the recommendations put forward thus far for improving the current waste management situation in the AMA are untenable. In this regard, it is highly recommended that the central government in collaboration with the local government and external funders take the necessary steps to put in place adequate infrastructure for the management of urban wastes including biomedical pollutants. Here, the risks associated with biomedical pollutants may be used as a keystone project to ensure that all stakeholders contribute meaningfully to the process. These include the construction of a state of the art municipal incineration technology mainly for the treatment of biomedical pollutants and a sanitary municipal landfill complete with leachate collection systems, gas extractors as well as plans for future remediation. The landfill must have an onsite material reclamation facility (MRF) where recyclables can be recovered. Additionally, a municipal waste water treatment facility is necessary for mitigating risks to ecosystems. Scientific methods such as ozonation and membrane filtration have been shown to effectively remove some classes of biomedical pollutants in wastewater (Heberer *et al.*, 2002; Huber *et al.,* 2003; Ternes *et al.,* 2003; Zwiener & Frimmel, 2000). Here, the risks associated with biomedical pollutants may be used as a keystone project to ensure that all stakeholders contribute meaningfully to the process. The management, operations and maintenance of these facilities can be facilitated through a co-management approach in which all relevant stakeholders participate in the process. This would ensure some amount of accountability.

8.8 Dealing with Resource Constraints

One of the central premises underlying the ecosystem approach is the need to consider environmental governance from an economic perspective (UNESCO, 2000). This principle recognizes the costs associated with environmental management as well as the economic benefits that can be derived from effective management practices. This is not the

situation in the AMA where all stakeholders interviewed identified resource constraints as a major problem militating against the attainment of effective waste management outcomes. To address this issue, there is a need to ensure the economic viability of the waste management process in the AMA. In the absence of this, all the recommendations put forward for improving the situation is unsustainable. Based on the field investigation several opportunities for ensuring financial viability are identified. Waste management is a public good and every individual generates some amount of residue each day. The implementation of a payroll waste management levy is seen as a good strategy. Here the central government is seen as the ideal body to take the lead. This will give stakeholders a sense of accountability over both the problem of waste management as well as the solution. The proceeds from the levy can be used to pay private contractors directly for the street sweeping, collection and disposal of wastes. This will go a long way in curtailing the conflicts and distrust held by residents toward private waste management service providers. The amount to be charged must be reasonable to guard against public backlash and be commensurate with the provision of quality services in order to avoid backlash. This can be determined by the government appointed waste regulator in consultation with the WMD.

8.9 Environmental Education

Environmental education is a vital tool in the waste management process and has proven to be effective in some areas. In Porto Alegre, Brazil, there is an *Environmental Atlas* that serves to provide ordinary citizens with solid knowledge base to necessary for ensuring effective outcomes in waste management (Menegat, 2002). Environmental education is therefore a key criterion worthy of consideration if any meaningful improvements are to be made in the management of urban wastes in the AMA. An approach will be to incorporate environmental education in the academic curriculum of first and second cycle institutions. Both the local and central governments are seen as playing a crucial role in this regard. Governments at all levels as well as non-governmental organizations (NGOs) may use advocacy as a tool for promoting effective waste management practices. Additionally, a risk communication strategy may be initiated by the central government in collaboration with

other stakeholders as a way of raising awareness in the AMA. The risk communication process can be facilitated through mass mediated messages including radio, television and newspapers and in all the major languages spoken in the AMA.

Drawing from the research findings as well as information derived from the existing body of knowledge, this thesis has outlined intervention strategies deemed suitable for ameliorating the management of urban wastes including biomedical pollutants in the AMA. The policy implications and contributions of this thesis to the body of knowledge is the subject of discussion in the next section.

8.10 Policy Implications and Contributions to the Body of Knowledge

The dominant discourse in the literature pertaining to waste management in developing countries has traditionally leaned heavily on the state-centric and technocratic approach to service delivery. The centralized approach has formed the basis of policy formulation and implementation, albeit to massive failures. The precariousness of the waste management situation in the AMA provides ample evidence to this effect. This thesis uncovers some major gaps in existing policy frameworks pertaining to the management of wastes and the environment. Although the needs for precautionary action, inter-sectoral co-operation, and public participation are trumpeted in current regulatory frameworks, these are not implemented in any meaningful way. Key environmental management tools such as adaptive management and risk communication are also conspicuously missing in current regulations. In addition to this, the current policy structure can be said to be heavy on rhetoric and lean on substance. For instance, the ESP talks about ways in which waste management practices must be improved without addressing how challenges associated with technological limitations and resource constraints might be addressed. Reference to biomedical pollutants in the ESP and NEP are also frustratingly vague. The major implications of these policy gaps are reflected in the state of precariousness surrounding the management of wastes and biomedical pollutants in the AMA. This thesis hopes to make a small but important contribution to the body of knowledge pertaining to the management of urban wastes and biomedical pollutants in developing countries. For decades, the dominant discourse in the

literature pertaining to the management of urban wastes in developing countries has leaned heavily on the centralized approach which has formed the basis of policy formulation and implementation. This has resulted in massive policy failures in many developing countries, as aptly demonstrated in the Accra example. It is hoped that the current study provide a refreshing way of thinking, planning and urban waste management decision in a developing country context.

8.11 Directions for Future Research

Based on the findings of the case study, several directions for future research have been identified and are adumbrated below:

1. How widespread is the use of hospital wastewater in urban agricultural practices?
2. What environmental and human health repercussions are linked with the use of hospital wastewater as a source of irrigating fresh urban produce?
3. Given the lack of wastewater treatment facilities in the AMA, what is the fate of surface, ground and drinking water in the AMA?
4. What is the quality of health among frontline waste management and healthcare delivery personnel given the widespread practice of not using protective gear in the handling of hazardous pollutants?
5. Are there any potential risks to humans who consume domestic livestock that feed on wastes from hospital dumps?
6. What is the air quality in areas where open crude burning of wastes including biomedical pollutants are practiced?
7. What is the current amount of plastic wastes generated in the AMA on an annual basis?

8.12 Conclusion

In conclusion, this research was undertaken against the backdrop of understanding and addressing challenges associated with the management of urban wastes including

biomedical pollutants in a developing country setting. A post-positivist epistemological approach was adopted which allowed for the fusion of both quantitative and qualitative methods in the data collection process. The research uncovered major deficiencies consistent with the literature pertaining to the management of urban wastes and biomedical pollutants developing countries. There are no special provisions in place for managing biomedical pollutants from healthcare activities and urban waste management service delivery was found to be facilitated within a 'collect and dispose' framework with very little emphasis placed on minimization, composting, or recycling. Even within this approach, many discrepancies were observed. The absence of sanitary landfills and incineration technologies results in widespread open dumping and crude burning practices. This was found to contribute to a myriad of environmental and public health risks. Underlying the ineffective waste management practices in the AMA are challenges associated with governance, corruption, feckless regulations and resource constraints. In response to gaps embedded in current environmental planning and management approaches, the Framework for Urban Management of the Environment (FUME) was developed. The FUME model consists of salient features of the precautionary principle, ecosystem approach, adaptive management, co-management, environmental risk management and integrated waste management. The entirety of the findings are presented methodically in this thesis, although the actual inquiry begun as an exploratory process.

Obviously, what can be studied within the realm of urban waste management in developing countries is limitless. The current study is an attempt to understand what can be done in the area of urban waste and biomedical pollutants in the AMA. In so doing the study did not provide what some would describe as a balance of all competing influences in the AMA. For instance, environmental non-governmental organizations did not get to participate in the research. Future research can include the voices of all those who were left out of this research. In spite of weak structures in the AMA, this research hopes to promote awareness by informing the reader, thus providing another tool for those advocating change in the management of urban wastes and biomedical pollutants in the AMA. It is hoped that this

research would provide stakeholders with fresh insights and provide a new way of thinking, planning and making decisions regarding the management of urban wastes, including biomedical pollutants generated during the course of healthcare activities.

Bibliography

Abdulla, F., Qdais, H., & Rabi, A. (2008). Site investigation on medical waste management practices in northern Jordan. *Waste Management*, 28, 450-458

Abu-Shair, O.J.R. (1997). Privatization and Development. London: Macmillan Press Ltd.

Adeyemi, A., Olorunfemi J., & Adewoye, T. (2001). Waste Scavenging in Third World Cities: A case study in Ilorin, Nigeria. *The Environmentalist*, 21, 93-96

Adlakha, A. (1996). International Brief Population Trends: Ghana *U.S. Department of Commerce, Economics and Statistics Administration. Bureau of the Census*

Agrawal, A. (1995). Indigenous and scientific knowledge: some critical moments. *Indigenous knowledge and Development Monitor* 3(3): 33-41

Agunwamba, J. (1998). Solid Waste Management in Nigeria: Problems and Issues. *Environmental; Management*, 22 (6) 849-856.

Ahmed, R. (1997). Hospital Waste Management in Pakistan. Case Study Report. Urban Waste Expertise Programme, UWEP, the Netherlands.

Aina, T. (1997). The state and civil society: Politics, government and social organization in African cities. In: C Rakodi (Ed). The Urban Challenge in Africa: Growth and Management of its large cities. Pp. 441-446. *UN University Press*: Tokyo

Alagoz, A., & Kocasoy, G. (2008). Determination of the best appropriate management methods of the healthcare-wastes in Istanbul. *Waste Management*, 28, 1227-1235

Alam, R., Chowdery M., Hasan G., Karanjit, B. & Shrestha L (2008). Generation, storage, collection and transportation of Municipal Solid Waste – A case study in the city of Kathmandu, capital of Nepal. *Waste Management 28: 1088-1097*.

Alexander, E. R. (1992). Approaches to Planning: Introducing Current Planning Theories, Concepts and Issues. Second edition, Gordon and Breach.

Alexander, E. R. (2003). Response to ' why do planning theory? *Planning Theory*, 2(3), 179-182.

Ali, M., Coad, A., Cotton, A.(1996). Education in municipal and informal Systems of solid

waste management. In Hamdi, N (Ed). Educating for Real: The Training of professionals for development practice. London: Intermediate Technology Publications. Pp. 149-162

Al-Khatib, I., Monou, M., Alsubu, M.M., & Kassinos, D. (2009). Dental Solid and Hazardous Waste Management and Safety Practices in Developing Countries: Nablus District, Palestine. *Waste Management and Research, vol 28, No 5 pp436-444*

Amanullah, N., (1995). Environmental management dilemma in Afghanistan. *Journal of Environmental Health* 58 (4): 28

Angerer J., Heinzow, B., Reimann, D., & Lehnert, G. (1992). Internal exposure to organic substances in a municipal waste incinerator. *International Archives of Environmental health,* 64, 265-273.

Anku, S. (1997). Solid Waste Management Policies and Strategies in Ghana: A position Paper. EPA, Ghana

Arce, A., and Long, N. (1992). The dynamics of knowledge: Interfaces between bureaucrats and peasants. In Long N. And Long A. (ed). Battlefields of Knowledge: The interlocking of theory and practice in social research and development. London, Routledge.

Arlosorrof, S. (1991) Developing countries struggle with waste management policies. *Waste Management and Research* 9 (6) 491-494

Arlosorrof, S. & Bartone, C. (1987). Assisting Developing Nations. *Biocycle* 28 (6) 43-45

Armstrong, A. (1993). Urban Crisis and Basic Services. Solid Waste in Dar es Salaam. Ekistics, 60, (358/359): 74-84

Arnstein, S. (1969). A Ladder of Citizen Participation. *Journal of the American Institute of Planners* 35:216-224

Arrow, K. (1958). 'Social Choice and Individual Values. New York: Wiley

Askarian, M., Vakili, M., Kabir, G. (2004). Results of a hospital waste survey in private hospitals in Fars province, Iran. *Waste Management*, 24, 347-352

Asolekar, S., & Gopichandran, R. (2005). Preventative Environmental Management: An Indian Perspective Foundation Books, New Delhi

Asomani-Boateng, R. (2007). Closing the Loop: Community-Based Organic Solid Waste Recycling, Urban Gardening and Land Use Planning in Ghana, West Africa. *Journal of Planning Education and Research 27:132-145*

Asomani-Boateng, R., & Haight, M. (1997/98). Assessment of Municipal Solid Waste Manaement Practices in Accra, Ghana. *Journal of Environmental systems,* 26(1): 41-55

Aumonier, J.R. (2003). Risk management of pharmaceuticals in the environment: the human pharmaceutical industry viewpoint. Paper presented at the EnvirPharma, Lyon, France.

Ayininuola, G., & Muibi, M. (2008). An engineering approach to solid waste collection system: Ibadan North as a case study. *Waste Management*, 28, 1681-1687

Babbie, E. (2001). *Practice of social research* (9th ed.). Belmont, CA: Wadsworth Thomson Learning.

Bagchi, A. (1990). Design, Construction and Monitoring of Sanitary Landfill. John Wiley & Sons: New York

Bakoglu, M., Karademir, A., & Ayberk, S. (2004). An evaluation of the Occupational Health Risks to Workers in a Hazardous Waste Incinerator. *Journal of Occupational Health,* 46: 156-164

Banfield E. C. (1959). 'Ends and Means in Planning' in Faludi, Andreas. 1973. A Reader in Planning Theory. Pegamon Press

Barnes, K.K. Christenson, S.C., Koplin, D.W., Focazio, M.J., Furlong, E.T., & Zaugg S.D. (2004). "Pharmaceuticals and other organic waste water contaminants with a leachate plume downgradient of a municipal landfill". *Ground Water Monitoring and Remediation, 24 (2), 119-126.*

Bartone, C. (1988). The Value in Wastes. *Decade Watch*. September pp 3-4

Bartone, C., Leite, L., Trieche, T., & Schertenleib, R. (1991). Private sector participation in municipal solid waste service. Experiences in Latin America. Waste Management and Research 9(6) pp. 496-509

Barrett, S. (1991). *Pathways*: Towards an ecosystem Approach. A Report of Phases 1 and 11 of an Environmental Audit of Toronto's East Bayfront and Port Industrial Area. Minister of Supply and Services Canada, Ottawa. April.

Bassey, B.E., Benka-Coker, M.O. and Aluyi, H.S. (2006). Characterization and management of solid medical wastes in the federal capital territory, Abuja Nigeria. *African Health Sciences. 6(1)58-63*

Batley, R. (1996). Public-Private Relationships and Performance in Service Provision. *Urban Studies,* 33(4/5): 723-751

Baud, I., & Schenk, H. (eds). Solid Waste Management, Modes, Assessment, Appraisals and Linkages in Bangalore. Monohar

Baum, H., (1996). Why the rational paradigm persists: Tales from the field. *Journal of Planning Education and Research* 15:127-34

Beattie, M., (1996). An Ecosystem Approach to Fish and Wildlife Conservation *Ecological Applications*, Vol. 6, No. 3 pp. 696-699. August

Beck, U. (1992). Risk society: towards a new modernity (M. Ritter, Trans.). London: Sage

Beede, D.N. & Bloom, D.E. (1995). The Economics of Municipal Solid Waste. The World Bank Research Observer, 10 (2): 113-50

Bell, A. (1994). Nonhuman nature and the ecosystem approach: The limits of anthropocentrism in the Great Lakes management. *Alternatives*, Vol. 20 Issue 3; pg. 20

Bengtsson J., Angelston, P., & Elmquist, T. (2003). Reserves, resilience and dynamic landscapes. *Ambio* 32: 389-96

Berkes, F. and Folke, C. (1998). Linking Social and Ecological Systems: Management Practices and Social Mechanisms for Building Resilience. Cambridge University Press: Cambridge.

Berkun M., Aras E., & Nemlioglu, S. (2005). Disposal of Solid Waste in Istanbul and along the Black Sea Coast of Turkey Waste *Management 25:847-855*

Beukering, P., Sehker, M., Gerlag, R. & Kumar V. (1999). Analyzing Urban Solid Waste in Developing Countries: A Perspective on Bangloire, India. Working Paper No. 24. London: CREED.

Bilitewski, B., Hardtle, G., & Marek, K. (1997). *Waste management* (A. Weissbach, H. Boeddicker Trans). Berlin: Springer.

Black, A. (2005). "Rural Communities and Sustainability". In Cocklin, C. & Dibden, J. (Eds). *Sustainability and Change in rural Australia*. Sidney: University of New South Wales Press Ltd.

Blais, A., & Dion, S. (eds). The Budget Maximizing Bureaucrat. Pittsburgh, PA: University of Pittsburgh Press

Blight, G., & Mbande, C. (1998). In Solid waste management: a critical issue for developing countries. Thomas Hope, Elizabeth (ed). University of the West Indies, Kingston

Blumberg, L., & Gottlieb, R. (1989). War on waste: can America win its battle with garbage? Island Press: Washington D.C

Boadi, & Kuitenan. (2002). Urban Waste Pollution in the Korle lagoon, Accra Ghana. *The Environmentalist*, (22) 301-309

Boadi, K. O., & Kuitenen, M. (2003) "Municipal Solid Waste Management in the Accra Metropolitan Area, Ghana" *The Environmentalist*, 23: 211-218

Bogdan R., & Taylor S.J. (1975). "Introduction to Qualitative Research Methods". New York: John Wiley

Bortolet, A.P., & Hanaki, K. (2007). Report: Citizen Participation as a Part of Integrated Solid Waste Management: Porto Alegre Case. Waste Management Research, vol. 25 no. 3 276-282

Bosselmann, K. (2008). The Principle of Sustainability: Transforming Law and Governence. Ashgate: Burlington

Bradshaw, B., (2003). Questioning the credibility and capacity of community-based resource management. *The Canadian Geographer* 47(2): 137-151.

Branch, M. C., (1975). Urban Planning theory. Stroudsburg, Pa :New York:

Briassoulis, H. (1989). Theoretical orientations in environmental planning: an inquiry into alternative approaches. *Environmental Management*, l3(4), 381-392.

Brown, C.V & Jackson, P.M. (1990). Public Sector Economics. Fourth Edition. Cambridge, MA: Basil Blackwell

Brunner, C. R. (2002). Incineration technologies. In G. Tchobanoglous and F. Kreith (Eds.), *Handbook of solid waste management,* (2nd ed.), (pp. 13.3-113.84). New York: McGraw-Hill.

Brunner, C., (1980). Design of Sewage Sludge Incineration Systems. Noyes Data Corporation: New Jersey

Brunner, C. R. (1984). Incineration Systems: Selection and Design. Van Norstrand Reinhold Company Limited: New York

Brunner, C. R. (1985). Hazardous Air Emissions from Incineration. Chapman and Hall: New York & London

Brunner, C. R. (1989). Handbook of Hazardous Waste Incineration. Tab Books Inc: Pennsylvania

Brunner, C. R. (1991). Handbook of Incineration Systems. McGraw-Hill: New York

Bubba, N., & Lamba, D. (1991). Urban Management in Kenya. *Environment and Urbanization,* 3 (1):37-95

Buchy, M., & Race D. (2001). The Twists and Turns of Community Participation in Natural Resource Management in Australia. *Journal of Environmental Planning and Management* 44(3), 293-308.

Burke, E.L., (1994) A survey of recent literature on medical waste. *Journal of Environmental Health* 56 (9), 11-14

Caiden, G.E., & Caiden C., (1994). Administrative Corruption. *Philippine Journal of Public Administration,* 38 (1), 1-17.

Cairns, J.J., (1999). Absence of certainty is not synonymous with absence of risk. Environmental Health Perspectives, 107 (2), A56-A57.

Caldwell, L.K., (1994). "Disharmony in the Great Lakes basin: institutional jurisdictions frustrate the ecosystem approach". *Alternatives*, Vol. 20, Issue. 3 pg. 26

Canadian Standards Association. (1997). CAN/CSA-Q850-97: Risk management: a guideline for decision-makers. Etobicoke, ON.

CBD, (2000). "The Ecosystem Approach". Available at www.cbd.int/ecosystem/ accessed October, 2008. Convention on Biological Diversity.

CEPA. (1999). Canadian Environmental Protection Act: The House of Commons of Canada, Bill C-32, as passed by the House of Commons, June 1, 1999.

Chandra, H., & Jamaluddin, K., Masih, L., & Agnihotri, K. (2006). "Cost-Benefit Analysis/Containment in Biomedical Waste Management: Model for Implementation". *Journal of Financial Management and Analysis*. July- Dec.

Chang, Y. (1995). Centralized Incineration Treatment of Infectious Waste for Regional Hospitals in Taiwan. *Waste Management & Research* 13, 241-257

Chapin, C. (1995). The Rag Pickers of Pune. *The UNESCO Courier*. March 18-19

Chapman, L. (1979). *Your Disobedient Servant*. Harmondsworth: Penguin

Checkoway, B. (1994) 'Paul Davidhoff and Advocacy Planning in Retrospect', Journal of the American Planning Association, 60:2 139-143

Cheema, G.S., (1986). Reaching the Poor: Project Implementation in Developing Countries. Boulder: Westview

Cheema, G.S. (1987). Urban Shelter and Services. New York: Praeger.

Chermisinoff, P., N. (2003). Handbook of Solid Waste Management and Minimization Technologies. Elsevier: Massachusetts

Choi, Y., (1983). Policy without Implementation: solid waste. *Environmental Management 7*,(3): p. 209-10

Christensen, N.L. (1996). The report of the Ecological Society of America Committee on the Scientific Basis for Ecosystem Management. *Ecological Applications*, 6(3): p. 665-691

Clavel P., (1994). The Evolution of Advocacy Planning. *Journal of the American Planning Association*, 60:2 146-149

Coker, A. (2009). Medical waste management in Ibadan, Nigeria: obstacles and prospects. *Waste Management* 29, p.804-811

Cointreau, S.J. (1982). Environmental Management of Urban Solid Waste in Developing Countries. Washington D.C: The World Bank.

Cointreu-Levine, S., (1994). Private Sector Participation in Municipal Waste Services in Developing Countries. Discussion Paper 13, Volume 1. World Bank Management Programme. Urban Management and the Environment.

Colby, M.E. (1990). Environmental Management in Development: The Evolution of Paradigms. *World Bank Discussion Paper 80*. Washington D.C: World Bank

Cooperrrider, A. (1996). Science as a Model for Ecosystem Management – Panacea or Problem? *Ecological Applications*, Vol. 6, No. 3, pp. 736-737, August.

Covello, V.T. (1989). Informing people about risks from chemicals, radiation, and other toxic substances: a review of obstacles to public understanding and effective risk communication. In: W. Leiss (Ed.), Prospects and problems in risk communication (pp. 1-49). Waterloo: University of Waterloo Press.

Creswell, J. W. (2003). *Research design : Qualitative, quantitative, and mixed methods approaches* (2nd ed.). Thousand Oaks, California.: Sage Publications.

Crittenden, B. & Kolaczkowski, S. (1995). Waste Minimization: A Practical Guide. Institute of Chemical Engineers: UK

Cunningham M., & Cunningham, W. (2004). Principles of Environmental Science: Inquiry and Applications. Second Edition,. McGraw-Hill

Da Silva, C., Hoppe. A., Ravanello, M & Mello, N. (2005). Medical waste management in the south of Brazil. *Waste Management*, 25, 600-605

Davies, D.,G. (1981). Property Rights and Economic Behaviour in Private and Government Enterprises: The Case of Australian Banking System. *Research in Law and Economics 3:111-142*

Dhamija, U., (2006). Sustainable Waste Management: Issues, Policies and Structures. Academic Foundation, New Delhi

Dalton, L., (1986). Why the Rational Paradigm Persists – The resistance of Professional Education and Practice to Alternative forms of Planning. *Journal of Planning Education and Research* 5(3): 147-153

Damgbani A., Savarypour G., Z. E., & Deihimfard, R., (2008). Municipal Solid Waste Management in Tehran: Current Practices, Opportunities and Challenges. Waste *Management 28 929-934*

Daughton, C.G., & Ternes, T.A. (1999). Pharmaceuticals and personal care products in the environment: Agents of subtle change? *Environmental Health Perspectives*, 107,907-938.

Davidhoff, P. (1965) 'Advocacy and Pluralism in Planning' Journal of the American Institute of Planners 31: (4): 277-295

Dawson, G. W., & Mercer, B., W., (1986). Hazardous Waste Management. John Wiley & Sons. US & Canada

DeFur, P. L., & Kaszuba, M. (2000). Implementing the precautionary principle. *The Science of the Total Environment*, 288(155-165).

Dennison, M. S., (1995). Environmental Reporting, Recordkeeping and Inspections: A Compliance Guide for Business and Industry. John Wiley and Sons: New York

Denzin, N.K., & Lincoln Y. S. (1994) *"Handbook of Qualitative Research"*. Thousand Oaks CA Sage Publications pp1-17

Diaw, K., Nnkya, T., Watson, V. (2002). Planning Education in Sub-Saharan Africa: Responding to the Demands of a Changing Context. Planning Practice and Research, Col 17, No. 3 337-348

Diaz, L.F., Savage, G.M., & Eggerth, L.L. (2005). Alternatives for the treatment and disposal of healthcare wastes in developing countries. *Waste Management, 25: 626-637*

Dobson, S. (1993). Why different regulatory decisions when the scientific base is similar? – environmental risk assessment. *Regulatory Toxicology and Pharmacology*, 17:p. 333-345

Daily Graphic (2011). Waste Contractors Asks AMA to pay them.

Dratwa, J. (2002). Taking risks with the precautionary principle: food (and the environment) for thought at the European Commission. Journal of Environmental Policy and Planning, 4, 197-213.

Eade, D. (1997). Capacity Building: An Approach to People Centred Development. Oxfam: UK and Ireland

EAHH, (2008). Ecosystem Approach to Human Health. *Ecosystem Approach to Human*

Health and Neurotoxics Working Group. Available from www.unites.uqam.ca/neuro/design/ecosystem *Accessed October, 2008.*

Elmquist, T., Folke, C., Magnus, N., Peterson. G., Bengtsson, J., Walker, B., & Norberg, J. (2003). Response diversity, ecosystem change and resilience. Frontiers in Ecology and the Environment. Vol. 1 no. 9.

Enger E., & Smith B. (2004). *Environmental Science: A study of interrelationships McGraw Hill* ninth edition

Epstein, E. (1997). Industrial Composting: Environmental Engineering and Facilities Management. Taylor and Francis: Boca Raton

Etter, R.G., Kisser, J.V.L., & Shuler, S.E. (1992). Medical Waste combustion. Current and future prospects. *Waste Age* 21, 77-78

Etzioni, A. (1967). 'Mixed Scanning: A "Third" Approach to Decision Making". In Faludi, Andreas. 1973. A Reader in Planning Theory. Pergamon Press.

Fadyomi, T.O. (1996). Brain Drain and Brain Gain in Africa: Causes, Dimensions and Consequences. In: Adepoju, A and Hammer, T. (eds). International Migration to and from Africa: Dimensions, Challenges and Prospects. Dakar: PHRDA

Faludi, A. (1973b). Planning theory. (1st ed.). Oxford ;New York: Pergamon

Faludi, A. (1973a). Reader in planning theory. (1st ed.). Oxford: Pergamon

Farazmand, A. (2007). Strategic Public Personnel Administration: Building and Managing Human Capital for the 21st Century. Praeger: Westport

Fardon, R. (1995). Counterworks: Managing the Diversity of Knowledge. London: Routledge

Fekade, W. (2000). Deficits in formal land management and informal responses under rapid urban growth: an international perspective. *Habitat International*, 24:137-150

Fernandez, A.L., (1993). Public-Private Partnerships in Solid Waste Management. *Regional Development Dialogue, 14 (3): 3-25*

Flyvbjerg, B. (2004). Five misunderstandings about case-study research. In: S. Clive, G. Gobo, J.F. Gubrium and D. Silverman (Eds.), *Qualitative research practice* (pp 420-434), London: SAGE Publications.

Folke, C., Pritchard, L., Berkes, F., Colding J., and Svedin, U. (1998). "The Problem of Fit between Ecosystems and Institutions". IHDP Working Paper. International Human Dimensions Programme on Global Environmental Change (IHDP), Bonn, Germany.

Fong, P. (1998). Zebra mussel spawning is induced in low concentrations of putative serotonin reuptake inhibitors. *Biology Bulletin, 194, 143-149*

Forester, J. (1987). 'Planning in the Face of Power'. University of California Press.

Forester, J. (1994) 'Bridging interests and community planning and the challenges of deliberative democracy', Journal of the American Planning Association 60 (2): 153-58

Forget, G & Lebel J. (2001). An Ecosystem Approach to Human Health. *International Journal of Occupational and Environmental Health*, Supplement to Volume 7, Number 2 April/June

Friedmann, J. (1973). Retracking America : A theory of transactive planning. Garden City, N.Y.: Anchor Press.

Friedmann, J. (1987). Planning in the public domain: From knowledge to action. Princeton, N.J.: Princeton University Press.

Friedmann, J. (1993). Towards a non-euclidian mode of planning. *The Journal of the American Planning Association*, 59(4), 482-485.

Friedmann, J. (2003). Why do planning theory? *Planning Theory*, 2(1), 7-10.

Furedy, C. (1984). Socio-political aspects of the recovery and recycling of urban wastes in Asia. *Conservation and Recycling*, 7 (2-4) pp. 167-173

Furedy, C (1993). Garbage: Exploring Non-Conventional Options in Asian Cities. *Environment and Urbanization,* 4 (2) pp 42-61

Gerlack L., & Bengston, D., (1994). "If Ecosystem Management is the Solution, What's the Problem? Eleven Callenges for Ecosystem Management". *Journal of Forestry, August*.

Gidman, P., Blore, I, Lorentzen, E., Schuttenbelt, P. (1995). Public Private Partnerships in

Urban Infrastructure Services. Habitat Working Paper No. 4. Urban Management Program, UNDP/UNCHS. Washington D.C.: The World Bank

Gilbert, R., Stevenson, D., Gerardet, H. & Stren, R. (1996). Making Cities Work: The Role of Local Authorities in the Urban Environment. London: Earthscan Publishing Ltd.

Goldberg, M., Siemiatyck, J., Dewar, R., Desy, M. & Rberdy, H. (1999). Risks of Developing Cancer Relative to Living near a Municipal Solid Waste Landfill Site in Montreal, Quebec, Canada". *Archives of Environmental Health* 291-296.

Goldman, B.A., Hulme, J.A., Johnson, C., & Marlin, A.T. (1986). Hazardous waste management: reducing the risk. *Council on Economic Priorities*: Washington D.C.

Goldstein, B.D. (1999). The precautionary principle and scientific research are not antithetical. *Environmental Health Perspectives*, 107(12), A594-A595.

Gonzalez. O., (1996). "Formulating an Ecosystem Approach to Environmental Protection". *Environmental Management* Vol. 20, NO. 5, pp. 597-605.

Government of Canada. (2001). A Canadian perspective on the precautionary approach/principle: discussion document. Retrieved May 10, 2004, from http://www.ec.gc.ca./econom/discussion_e.htm

Government of Canada. (2003). A framework for the application of precaution in science-based decision making about risk (No. ISBN 0-662-67486-3, Cat. No. CP22-70/2003).

Government of Ghana (2002). Ghana Landfill Guidelines. Series Number 1. Environmental Protection Agency

Government of Ghana (2002). Guidelines for Management of Healthcare and Veterinary Waste in Ghana. *Environmental Protection Agency, No. 2*

Government of Ghana (2002). Manual for the Preparation of District Waste Management Plans. *Environmental Protection Agency. No. 3*

Government of Ghana (2001). Environmental Sanitation Policy. Ministry of Local Government and Rural Development

Government of Ghana (2010). Greater Accra Region. Retrieved June, 2011 from www.ghanadistricts.com

Government of Northwest Territories. (2005). Guidelines for the Management Biomedical Waste in the Northwest Territories

Government of Ontario, Ministry of Environment (1994). The Management of Biomedical Waste in Ontario. Guideline C-4 (formerly 14-05).

Grant R., & Yankson, P. (2003). City Profile, Accra. *Cities*, Volume 20, No. 1 p. 65-74

Grumbine, E.R. (1994). What is Ecosystem Management? *Conservation Biology*, 8(1): p. 27-28

Guba, E.G. (1981). Criteria for assessing the trustworthiness of naturalistic inquiries. *Educational Communication and Technology Journal, 19*(2), 75-91.

Guba, E.G. and Lincoln, Y. S. (1994).Competing paradigms in qualitative research. In N. K. Denzin and Y.S. Lincoln (Eds.), *Handbook of qualitative research* (pp.105-117). Thousand Oaks, CA: Sage.

Guinee J.B. (2002). Handbook on life cycle assessment: operational guide to the ISO standards. Kluwer Academic Publishers, New York.

Gunton, T. (1984). The Role of the Professional Planner. *Canadian Public Administration* Fall 1984 pp 399-417

Gupta, A., (1992). Building Upon People's Ecological Knowledge: Framework for Studying Culturally Embedded CPR Institutions. Indian Institute of Management. Ahmedabad.

Gupta, S., & Boojh, R. (2006). Biomedical Waste Management Practices at Belrampur Hospital, Lucknow, India". *Waste Management and Research* 54: 584-591

Hackett, S., C. (2001). Environmental and Natural Resource Economics: Theory, Policy and the Sustainable Society. Second Edition. M.E. Sharp: New York

Hai, L.H. (1988). Urban Services in a Plural Society: Approaches in Malaysia. In D.A. Rondinelli and G.S. Cheema. Ed: Urban Services in Developing Countries: Public and Private Roles in Urban Development, London: Macmillan Press p. 125-146

Haight, M.E. (1991). Municipal solid waste management: Making decisions in the face of uncertainty. Waterloo: University of Waterloo Press

Haight, M.E. & Taylor, P. (2000). A Manual for Composting in Hotels: A Guide to

Composting Yard and Food Wastes for Hotels in Thailand. Canadian Universities Consortium: Urban Environmental Management Project.

Hance, B. J., Chess, C., & Sandman, P. M. (1989). Setting a context for explaining risk. Risk Analysis, 9(1), 113-117.

Hardoy, J. E., & Satterthwaite, D. (2001). Environmental Problems in an urbanizing world. Earthscan: London.

Harremoes, P., Gee, D., MacGarvin, M., Stirling, A., Keys, J., Wynne, B. (2002). Twelve late lessons. In P. Harremoes, D. Gee, M. Macgarvin, A. Stirling, J. Keys, B. Wynne & S. Guedes Vaz (Eds..), The precautionary principle in the 20th century. London: Earthscan Publications Ltd.

Harris, N. (2002). Collaborative Planning: From Theoretical Foundations to Practice Forms. In: *Planning Futures, New Directions for Planning Theory* Edited by Allmendinger P. & Tewdwr-Jones M. Routledge Publications, London & New York. 2002.

Harwood S. (2003) 'Environmental Justice on the Streets: Advocacy Planning as a Tool to Contest Environmental Racism. *Journal of Planning Education and Research* 23:24-38

Hassan, M., Ahmed, S., Rahman, K., & Biswas T. (2008). "Pattern of Medical Waste Management: Existing Scenario in Dhaka City, Bangladesh" *Public Health 8:36*

Hatry, H. (1983). A Review of Private Approaches for Delivery of Public Services. Washington D.C: The Urban Institute Press

Haug, R. T. (1993). The Practical Handbook of Compost Engineering. Lewis Publishers:

Healey, P. (1996). The communicative turn in planning theory and its implications or special strategy formation. Environment and Planning B: *Planning and Design*, 23, 217-234.

Healey, P. (1997).Collaborative Planning: Shaping Places in Fragmented Societies. University of British Columbia Press.

Healey, P., (2003). Collaborative Planning in Perspective. *Planning Theory* 2 (2) 101-123

Healey, S. (2001). Risk as social process: The end of' the age of appealing to the facts? *Journal of Hazardous Materials*, 86, 39-53.

Health Canada. (1998, December 31 2002). The HPB risk management franmework. Retrieved February 4, 2004, from http://www. hc-sc.gc.ca/sab-ccs/mar1998_apph_hpb_risk_e.html.

Heiman, M. (1990). From "Not in my backyard" to Not in anybody's backyard"! Grassroots challenge to hazardous waste facility siting. *APA Journal* 56, 3: 359-62.

Heissenbuttel, A. E. (1996). Ecosystem management – principles for practical application. Ecological Applications, 6(3): p. 730-732

Hempel, L. C. (1996). Environmental Governance: The Global Challenge. Island Press: Washington D.C

Henschel, K.-P., Wenzel, A., Diedrich, M., & Fliedner, A. (1997). Environmental hazard assessment of pharmaceuticals. Regulatory Toxicology and Pharmacology, 25, 220-225.

Hill, M. (2004, 2010). Understanding Environmental Pollution. Second Edition. Cambridge University Press. Cambridge

Hodge, G. (1991) 'Planning Canadian Communities'. 2nd Edition Nelson Canada.

Holling, C. S. (Ed.). (1978). Adaptive environmental assessment and management. Chichester: John Wiley & Sons.

Holling, C. S. (1996). Surprise for Science, Resilience for Ecosystems, and Incentives for People. *Ecological Applications*, Vol. 6, No. 3, August, pp. 733-735).

Hood, C., Jones, D. K. C., Pidgeon, N., Turner, B., Bibson, R., Bevan-Davies, C. (1992). Risk management. In The Royal Society (Ed.), Risk: analysis, perception and management (pp.135-200). London: The Royal Society.

Hoornweg, D., and Thomas, L. (1999). What a waste: Solid Waste Management in Asia. Washington D.C.: Urban Development Sector Unit, World Bank

Hooper, B., McDonald G., and Mitchell B., (1999). 'Facilitating Integrated Resource and Environmental Management: Australian and Canadian Perspective'. *Journal of Environmental Planning and Management* 42 (5): 747-766

Hope, K. R. (2000). Corruption and Development in Africa. In: Hope Sr., K. R., and

Chikulo, B. C. (eds). Corruption and Development in Africa: Lessons from Country Case Studies. Macmillan and St Martin's Press

Horne, R., Verghese, K., & Grant, T. (2009). Life cycle assessment: principles, practice and prospects CSIRO Publishing, Collingwood

Hornsby-Smith, M., (1993). Gaining Access. In N. Gilbert (Ed), Researching Social Life p. 52-67 London: Sage

Hostovsky, C. (2000). Integrating Planning Theory and Waste Management – An Annotated Bibliography. Journal of Planning Literature, Vol. 15 No. 2

Hostovsky, C. (2006). The Paradox of the Rational Comprehensive Model. *Journal of Planning Literature*, 15:12

Hrudey, S.E. (1996). A critical review of current issues in risk assessment and risk management. In D. Del Bel Belluz & J.H. Shortreed (Eds.), Technical for risk issues in business and regulatory decision-making (p. 17-31). Waterloo: Institute for Risk Research.
http://www.riskworld.com/Nreports/1997/risk-rpt/pdf/EPAJAN.PDF

Hudson, B. M. (1979). Comparison of current planning theories: counterparts and contradictions. *Journal of the American Planning Association, 45*(4), 387-398.

Innes, J., and Booher D. (1999). Consensus Building and Complex Adaptive Systems: A Framework for Evaluating Collaborative Planning'. *Journal of the American Planning Association 65*: 412-430

IETC (2000). International Source Book on Solid Waste management. Osaka: UNEP, International Environmental Technology Centre

Izeogu, C. V. (1989). Urban Development and the Environment in Port Harcourt. *Environment and Urbanization* (1) 59-68

Izugbara, C., & Umoh, J., (2004). Indigenous Waste Management Practices among the Ngwa of Southeastern Nigeria: Some Lessons and Policy Implications. *The Environmentalist*, 24, 87-92

Jackson, P. (1982). The Political Economy of Bureaucracy. London: Philip Allen

Jardine, C.G., & Hrudey, S.E. (1997). Mixed messages in risk communication. *Risk analysis,*

17(4), 489-498.

Jobling, S., Nolan, M., Tyler, C.R., Brightly, G., & Sumpter, J.P. (1998). Widespread sexual disruption in wild fish. Environmental Science and Technology, 32, 2498-2506.

Johnke, B. (1992). Waste incineration - an important element of the integrated waste management system in Germany. *Waste Management & Research, 10*(4), 303-315.

Jones, D.B., Greenberg, S & Drew, J. (1980). Service Deliveri in the City: Citizen Demand and Bureaucratic Rules. New York: Longman

Jordan, A., & O'Riordan, T. (1999). The precautionary principle in contemporary environmental policy and politics. In C. Raffensperger & J. A. Tickner (Eds.), Protecting public health & the environment: implementing the precautionary principle (pp.15-35). Washington, D.C.: Island Press.

Kasseva, M., & Mbuligwe, S. (2000). Ramifications of solid waste disposal site relocation in urban areas of developing countries: a case study in Tanzania. *Resources, Conservation and Recycling*, 28, 147-161

Kay J., & Schneider, E. (1994). Embracing complexity: The challenge of the ecosystem approach. *Alternatives* Vol. 20, Iss. 3 pg. 32

Kay, J.J., Boyle, M., Regier, H. & Francis G. (1999). "An Ecosystem Approach for Sustainability: Addressing the challenge of Complexity". *Futures*, Volume 31 #7 pp. 721-742.

Keith, R. (1994). The Ecosystem Approach: Implications for the North. *Northern Perspectives*, Volume 22, Number 1, Spring.

Keller, J. (1995).Decolonization, Independence and the Failure of Politics. Indiana University Press. Bloomington 1995

Kellert, S., Mehta, J., Ebbin, S., and Lichtenfeld, L. (2000). 'Community Natural Resource Management: Promise, Rhetoric and Reality'. Society and Natural Resources 16: 473-490

Kessler, W.B. (1992). New perspective for sustainable natural resources management. Ecological applications, 2(3): p. 221-225

Kgathi, D., & Ballane, B. (2001). Instruments for sustainable solid waste management in Botswana. *Waste Management & Research*, 19, 342-35315, 477-494.

Khan, M. (1996). A typology of Corrupt Transaction in Developing Countries. IDS Bulletin 8 (5)

Kirk, J., & Miller, M. L. (1986). Reliability and Validity in Qualitative Research. Qualitative Research Series, 1. Beverly Hills, CA: Sage Publications.

Kironode, J.L. (Dar es Salaam, Tanzania. In A.G. Onibokun 9ed). Managing the Monster: Urban Waste and Governance in Africa, pp.101-172. Ottawa :IDRC

Klangsin, P., Harding, A.K. (1998). "Medical waste treatment and disposal methods used by hospitals in Oregon, Washington and Idaho". *Journal of Air and Waste Management Association* 48, 516-526.

Klitgaard, R. (1997). Cleaning up and Invigorating the Civil Service. Public Administration and Development, 17, 487-509

Koerner, R. M., & Daniel, D.E. (1997).Final Covers for Solid Waste Landfills and Abandoned Dumps. ASCE: USA

Korfmacher, K. (1997). "Solid Waste Collection Systems in Developing Urban Areas of South Africa: An Overview and Case Study". *Waste Management & Research,* 15, 477-494.

Kreith, F. & Tchobanoglous, G. (2002). *Handbook of solid waste management* (2nd ed.), New York: McGraw-Hill companies.

Kriebel, D., Tickner, J., Epstein, P., Lemons, J., Levins, R., Loechler, E. L. (2001). The precautionary principle in environmental science. *Environmental Health Perspectives*, 109(9), 871-876.

Krumholz, N., & Forester, J. (1990) Making Equity Planning Work: Leadership in the Public Sector. Philadelphia: Temple University Press.

Krumholz, N. (1994) Advocacy Planning: Can it Move to the Centre? *Journal of the American Planning Association*, 60:2 150-151

Lang, R. (1990). Equity in siting solid waste management facilities. *Plan Canada* 30, 2:5-13

Lange, R., & Dietrich, D. (2002). Environmental risk assessment of pharmaceutical drug substances—conceptual considerations. *Toxicology Letters*, 131, 97-104.

Lardinois, I. & van der Klundert, A. (1994). Recovery of Organic Waste in Cities. *ILEIA Newsletter,* 10 (10): 6-8

Larsson, D.G.J., Adolfsson-Erici, M., Parkkonen, J., Pettersson, M., Berg, A. H., Olsson, P. – E. (1999). "Ethinyloestraiol –an undesired fish contraceptive?". *Aquatic Toxicology, 45, 91-97*

Lebel, J. (2003). "Health: An Ecosystem Approach". International Development Research Council, (IDRC). Ottawa, Canada

Leduka, R.C. (1991). Aspects of urban management in Lesotho. Paper presented at the RUPSEA Conference on Urban management in Southern and Eastern Africa, Lilongwe, Malawi, October 7-10

Lee-Smith, D., & Stren, R.E. (1991). New Perspectives in African Urban Management. *Environment and Urbanization,* 3 (1) 23-26

Leiss, W., & Chociolko, C. (1994). Risk and responsibility. Montreal & Kingston: McGill-Queen's University Press.

Lemann, M., F. (2008). Waste Management. International Academic Publishers: Bern.

Lessard, G. (1998). An adaptive approach to planning and decision-making. *Landscape and Urban Planning,* 40, 81-87.

Levendis, Y.A., Atal, A., Carlson, J., & Quintana M. (2001). "PAH and soot emissions from burning components of medical waste: examination/surgical gloves and cotton pads". *Chemosphere* (42) 775-783

Levine, C. H. (1984). Citizenship and Service Delivery: The Promise of Co-Production. *Public Administration Review,* 44:178-187

Levy, G. M., (2000). Packaging, Policy and the Environment. Aspen Publishers

Lindblom, C. E. (1959). The science of "muddling through". *Public Administration Review,* 19, 79-88

Lloyd, O., Lloyd, M., Williams, F., & Lawson A. (1988). Twinning in human populations and in cattle exposed to air pollution from incinerators. *British Journal of Industrial Medicine* (45). 556-560

Lofland, J. (1972). Analyzing Social Settings. Belmont: Wadsworth

Loraine G., A., & Pettigrove, M. E. (2006). Seasonal variations in concentrations of pharmaceuticals and personal care products in drinking water and reclaimed waste water in southern California". *Environmental Science and Technology, 40(3), 687-695.*

McDougall, F. R., White, P., Franke, M., and Hindle, P. (2001). *Integrated solid waste management: A life cycle inventory*. Oxford, UK; Malden, MA: Blackwell Science.

Maimone M. (1985). 'An application of multi-criteria evaluation in assessing municipal solid waste treatment and disposal systems'. Waste Management and Research 3: 217-31.

Malkin R., Brandt-Ruaf, P., Graziano, J., & Parides, M. (1992). Blood Lead Levels in Incinerator Workers. *Environmental Research* 59, 265-270

Malpezzi, S. & Sa-Adu, J., (1996). What have African housing policies brought? Real Estate Economics, 24 (2): 25-40

Manga, V., Forton, O., Read, A. (2008). "Waste Management in Cameroon: A new policy perspective? *Resources, Conservation and Recycling*, 52, 592-600.

Manyele. S.V. (2004). Effects of improper hospital-waste management on occupational health and safety. *African Newsletter on Occupational Health and Safety*. 14: 30-33

Mao, I., Chen, C., Lin, Y & Chen, M. (2007). Airborne particle PM 2.5/PM10 mass distribution and particle-bound PAH concentrations near a medical waste incinerator. *Atmospheric Environment* (41) 2467-2475

Margerum, R. (1997). Integrated Environmental Management: The Foundations for Social Practice. *Environmental Management* 24(2): 151-166

Margerum, R.D and S. Born. (1995). Integrated environmental management: moving from theory to practice. *Journal of Environmental Planning and Management*, 38(3): p. 371-391

Marris, P. (1994). Advocacy Planning as a bridge between the professional and the Political. *Journal of the American Planning Association*, 60:2 143-46

Marttunen, M., & Vehanen, T. (2004). Toward adaptive management: the impacts of

different management strategies on fish stocks and fisheries in a large regulated lake. Environmental Management, 33(6), 840-854.

Masaki, K. (1997). Power, Participation and Policy. The emancipatory Evolution of the "Elite Controlled" Policy Process. Lexington Books, UK

Mato R., Kassenga, G. (1997). A Study on the problems of management of medical solid wastes in Dar es Salaam and their remedial measures. *Resource, Conservation and Recycling* 25, 271-287

Mato, R., & Kaseva, M. (1999). "Critical review of industrial and medical waste practices in Dar es Salaam City". *Resource, Conservation and Recycling* 25, 271-287

Mbaku, J. (2008). Bureaucratic Corruption in Africa: The Futility of Cleanups" The *Cato Journal*, vol. 16, No. 1

Mbongwe, B., Mmereki, B., & Magashula, A. (2008). Healthcare Waste Management: Current Practices in Selected Healthcare Facilities, Botswana. *Waste Management 28, 226-233*

McCall, M.K. (1996). ITK in East African Farming Systems. Indigenous Knowledge and Development Monitor, 4 (1).

McColl, S. (2000). Environmental health risk management: a primer for Canadians. Network for Environmental Risk Assessment and management: Waterloo

McDougall, F. R., White, P., Franke, M., & Hindle, P. (2001). *Integrated solid waste management: A life cycle inventory*. Oxford, UK; Malden, MA: Blackwell Science.

McGarvin, M. (2001). Science, precaution, facts and values. In: T. O'Riordan, J. Cameron & A. Jordan (Eds.), Reinterpreting the precautionary principle (pp.35-60).

McGuirk, P. (2001) 'Situating communicative planning theory: context, power and knowledge'. Environment and Planning A 33: 195-217

McLaren, V.W., & Yu, C., C. (1997). Solid Waste Recycling Behaviour of Industrial-Commercial-Institutional Establishments. Special Issue: Industry and the Environment. *Growth and Change, v28, n1 p93(17)*

McLean, M., Watson, H.K. and Muswema, A. (2006). Veterinary waste disposal: practice and policy in Durban, South Africa (2001-2003). *Waste Management* 27: 902-911

Melosi, M., V. (2005). Garbage in the Cities. Refuse, Reform and the Environment. University of Pittsburgh Press: Pittsburgh

Medina, M. (1993). Collecting recyclables in Metro Manila. *Biocycle* 34 (6): 51-53

Menegat, R. (2002). Participatory Democracy and Sustainable Development: Integrated Urban Environmental Management in Porto Alegre, Brazil. In Environment and Urbanization Volume 14, Number 2, October 2002

Meredith, T. C. (1997). Making knowledge Powerful. Alternative Journal, 23 (4): 28-35

Merillot, J.M. (1996). Perspectives and State of the Art of Composting in France. In. Betoldi et al (eds). The Science of Composting. Chapman & Hall: UK

Miles, M.B. and Huberman, A.M. (1994).*Qualitative data analysis. An expanded sourcebook* (2nd ed.). Thousand Oaks, CA: SAGE Publications.

Mitchell, B. (2002). Resource and environmental management. Harlow, UK: Pearson Education: 298

Mitchell, N. (1997). 'Resource and Environmental Management'. Longman, London

Mittelstaedt, M. (2003). Drug traces found in cities' water. The Globe and Mail, February 10, p. 1.

Mohee, R., (2005). "Medical wastes characterization in healthcare institutions in Mauritius". *Waste Management*, 25, 575-581

Moote, M., McClaren M., AND Chickering, D. (1997). Theory in Practice: Applying Participatory democracy theory to public land planning. Environmental Management 21(6): 877-889

Moreno, J., Rios, F.R., & Lardinos, I. (1999). Solid Waste Management in Latin America: The Role of Micro and Small Enterprises and Cooperatives. *Urban Waste Series*, 5 Gouda: Waste

Morgan, G. (1980) Paradigms, Metaphors and Puzzle solving in Organization Communication. *Administrative Science Quarterly*, 1980, 25, 608-621

Mosha, A.C. (1990). Urbanization and Environment – Case Study: Dar es Salaam. In, The

Environment and the City-Case Studies: International Society of City and Regional Planners (eds). ISCRP: Amsterdam

Muench, L. H. & Muench, C. Z. (1968). Planning and Anti Planning in Nigeria. American Journal of Planning, 34: 374-381

Muhlich, M., Scherrer, M., Daschner F.D. (2003). "Comparison of infectious waste management in European hospitals". *Journal of Hospital Infections 55: 260-268.*

Murphy, S., & Breman, J. (2001). Gaps in the Childhood Malaria Burden in Africa: Cerebrial Malaria, Neurological Sequeale, Anemia, Respiratory Distress, Hypoglycemia and Complications of Pregnancy. *American Journal of TropicalMedicine and Hygyiene, 64:57-67*

Musandu-Nyamayaro, O. (1991). Urban Management in Zimbabwe: the case of Harare. Paper presented as the RUPSEA Conference on Urban Management in Southern and Eastern Africa. Lilongwe, Malawi. October, 7-10

Mwafongo, W. M. K. (1991). Rapid Urban Growth: Implications for urban management in Malawi. Paper presented as the RUPSEA Conference on Urban Management in Southern and Eastern Africa. Lilongwe, Malawi. October, 7-10

Mwanthi, M., Nyabola L., & Tenambergen E. (1997). "*Solid waste management in Nairobi City: knowledge and attitudes*". *Journal of Environmental Health* 60 (5): 23
National Research Concil. (1983). Risk assessment in the federal government: managing the process. Washington, D.C.: National Academy Press.

Nag, A. (2005). Environmental Education and Solid Waste Management. New Age International

Needleman M., & Needleman, C. (1974) 'Guerrillas in the Bureaucracy: The Community Planning Experience in the United States'. New York: John Wiley

Nemathaga, F., Maringa, S., & Chimuka L. (2007). Hospital Solid Waste Management Practices in Limpopo Province: A Case Study of Two Hospitals. *Waste Management*

Niskanen, W.A. (1971). Bureaucracy and Representative Government. Chicago: Aldine Atherton

Ogu, V., (2000). Private sector participation and municipal waste management in Benin City, Nigeria. *Environment and Urbanization*, 12(2) 103-117.

Ohnesorgen, F. (1993). Sorting Out Solid Waste. *Public Management, 75: (3)9.*

Okpala, D.C. (1987). Received Concepts and Theories in African Urbanization Studies and Management Strategies: A Critique. *Urban Studies*, 24:137-150

O'Leary, P. (1995). Decision-makers guide to solid waste management. Second Edition, USEPA, Washington DC

Oluwande, P.A. (1984). Assessment of solid waste management problems in China and Africa. In Holmes, J.R (eds). Managing solid waste in developing countries. John Wiley and Sons: New York

Onibokun, A. G. (1999). Managing the Monster: Urban Waste and Governance in Africa. IDRC, Ottawa

Onibokun A. & Kumuyi, A. (1999). "Ibadan, Nigeria". In managing the monster: urban waste and governance in Africa: IDRC, Ottawa,

Organization for Economic Cooperation and Development (2001). Extended Producer Responsibility: A Guidance Manual for Governments. OECD Publications.

Organization for Economic Cooperation and Development (2008). Environmental Outlook to 2030. OECD Publications.

O'Riordan, T. (2001). The precautionary principle and civic science. In T. O'Riordan, J. Cameron & A. Jordan (Eds.), Reinterpreting the precautionary principle (pp. 95-111). London: Cameron May.

Osei, F. B. and Duker, A**.** (2008). Spatial dependency of V. cholera prevalence on open space refuse dumps in Kumasi, Ghana: a spatial statistical modelling. *International Journal of Health Geographic's 7:62, p:1-17*

Oskamp, S. (1995). Resource Conservation and Recylcing: Behaviour and Policy. *Journal of Social Issues, 51 (4):157-159*

Outhwaite, W., (1994). 'Habermas: a critical introduction'. Cambridge, United Kingdom, Polity

Paine, R.T., Tegner, M.J., & Johnson, E.A. (1998). Compounded perturbations yield ecosystem surprises. *Ecosystems*, 1:535-45

Paris, I. (2000). West Management in West African Cities. ISWA News No. 3

Parkins, J. (2002). 'Forest Management and Advocacy Groups in Alberta: An Empirical Critique of an Emergent Public Sphere'. *Canadian Journal of Sociology* 27(2): 163-184

Patil, G., & Pokhrel, K. (2005). Biomedical Waste Management in an Indian Hospital: A Case Study. *Waste Management* 25 592-599

Patton, M. (1990) Qualitative Evaluation and Research Methods (2nd Ed). Newbury Park, CA Sage Publications 1990

Patton, C.,V. & Sawicki, D.,S. (1993). Basic Methods of Policy Analysis and Planning. Englewood Cliffs, NJ: Prentice- Hall, Inc., 2d edition.

Paulson, D. (1998). Collaborative Management of Public Rangeland in Wyoming: Lessons in Co-Management. *Professional Geographer* 50(3): 301-315

Peattie, L. (1968) Reflections on Advocacy Planning. *Journal of the American Planning Association,* 34:2, 80-88

Pery, J. & Vanderklein, E. (1996). Water Quality: Management of a Natural Resource. Blackwell Science, Camobridge, MA

Petts, J. (1994). Incineration as a waste management option. In R.E. Hester and R.M. Harrison (Eds.), *Waste Incineration and the Environment* (pp. 1-25). Cambridge, UK: The Royal Society of Chemistry.

Petts, J. (1992). Incineration risk perceptions and public concern: experience in the U.K. improving risk communication. *Waste Management and Research, 10*(2), 169-182.

Piven F., (1970) Who does the Advocacy Planner Serve? *Social Policy* 1 (1): 32-37

Plummer, J. (2002). Focusing partnerships: a source book for municipal capacity building in public- private partnerships. Earthscan Publications, London

Post, J. (1999). The Problems and Potentials of Privatizing Solid Waste Management in Kumasi, Ghana. *Habitat International,* 23 (2): 201-215

Potter, R. (1994). Urbanization in the Third World. Oxford: oxford University Press

Porter, R.C. (2002). *The economics of waste*. Washington, DC: Resources for the Future.

Pruss, A., Giroult, E., & Rushbrook, P. (1999). Eds. "Safe Management of Wastes from Health-care Activities" *World Health Organization*, Geneva

Pugh, C. (2000). Sustainability in Squatter Settlements. In C. Pugh Ed. *Sustainable Cities in Developing Countries,* London: Earthscan p.135-151

Purdom, C. E., Hardiman, P.A., Bye, V.J., Eno, N.C., Tyler, C. R., & Sumpter, J. R. (1994). Estrogenic effects of effluents from sewage treatment works. Chemical Ecology, 8, 275-285.

Qadeer, A.M., (1983). "Urban Development in the Third World". New York, Praeger.

Quiroz, C. (1996). Local Knowledge Systems Contribute to Sustainable Development. *Indigenous Knowledge and Development Monitor*, (4) 1.

Quijano, R. F., (2003). "Elements of the Precautionary Principle. In J. A. Tickner (Ed.) Precaution, Environmental Science and Preventive Public Policy (pp. 21-27). Washington : Island Press.

Rand, T., Haukohl, J. &Marxen, U. (2000).*Municipal solid waste incineration: Requirements for a successful project*. Washington, D.C.: World Bank

Rao. S., Ramyal, R., Bhatia S., & Sharma V, *(2004). "Biomedical Waste Management: An Infrastructural Survey of Hospitals" MJAFI 60: 379-382*

Rapiti, E., Sperati, A., Fano, V., Dell'Orco, V., & Forastiere F. (1997). "Mortality among Workers at Municipal Waste Incinerators in Rome: A Retrospective Cohort Study". *American Journal of Industrial Medicine* (31): 659-661

Rapport, D.J. (1992) Evaluating ecosystem health. *Journal of Aquatic Ecosystem Health*, 1: p. 15 -24

Ray, R., &Thorpe, R. B. (2007). A comparison of gasification with pyrolysis for the recycling of plastic containing wastes. *International Journal of Chemical Reactor Engineering*, *5*, Article 85A.

Read A., Phillips P., & Robinson G**.** (1998) "Landfill as a future waste management option in England: the view of landfill operators". *The Geographic Journal*, 164 (1): 55

Redclift M. (1995). "The Environment and Structural Adjustment: Lessons for Policy Interventions in the 1990s". *Journal of Environmental Management* (44), 55-68).

Renn, O. (2004). Perception of risks. Toxicology Letters, 149-413. Research, 5(4), 301-316.

Riddell, B. (1997). "Structural adjustment programmes and the city in tropical Africa". *Urban Studies*, v.34, n.8, 1297(11).

Robinson, R. (2006). "Sustainable Design: framing a definition. Definitions are only the beginning". Ontario Planning Journal, Vol. 21, No. 3, pp. 13-16

Rogers, M. D. (2001). Scientific and technological uncertainty, the precautionary principle, scenarios and risk management. Journal of Risk Research, 4(1), 1-15.

Rogers, M. D. (2003). Risk analysis under uncertainty, the Precautionary Principle, and the new EU chemicals strategy. Regulatory Toxicology and Pharmacology, 37, 370-381.

Rogers, M.D. (2001). Scientific and technological uncertainty, the precautionary principle, scenarios and risk management. *Journal of Risk Research, 4(1), 1-15*

Rogoff, M., J., & Screve, F. (1987). Waste to Energy: Technologies and Project Implementation. Noyes Publications: Massachusetts

Romanos, M & Chifos, C., (1996). Contributions of Informal Sector to Environmental Management. Regional Development Dialogue, 17 (1): 122-155

Rondinelli, D. (1981). Government Decentralization in Comparative Perspective: Theory and Practice in Developing Countries. International Review of Administrative Sciences, Sudan's Experiment with Devolution. *Journal of Modern African Studies, Vol. 19, No. 4, pp. 595-624*

Rondinelli, D. (1993). Development Projects as Policy Experiments: An Adaptive Approach to Development Administration. Routledge, London AND New York, Second Edition.

Rose-Ackerman, S. (1999). Corruption and Government: Causes, Consequences and Reform. Cambridge: Cambridge University Press.

Rowe, S. (1992). Landfill Planning in Ontario – Bringing in the public. *Plan Canada*, 22-25

Royal Commission on the Future of the Toronto Waterfront, (1990). Watershed: Interim Report: August. Ministry of Supplies and Services, Ottawa, Canada.

Ruckelhaus, W. D. (1990). Risk, science and democracy. In: T. S. Glickman & M. Gough

(Eds.), Reading in risk (pp. 105-118). Washington: Resources for the future.

Rutala, W.A., & Weber C. (1991). Infectious waste – mismatch between science and policy. *The New England Journal of Medicine*, 325, (578-581)

Ryder, R. (1997). "Sustainable" incineration and death by dioxin. *The Ecologist*, July-August 27(4). 135

Sager T. (1994). 'Communicative Planning Theory' Avebury, Aldershot

Sanderson, H., Johnson, D. J., Reitsma, T., Brain, R. A., Wilson, C. J., & Solomon, K. R. (2004). Ranking and prioritization of environmental risks of pharmaceuticals in surface waters. Regulatory Toxicology and Pharmacology, 39, 158-183.

Santillo, D., Stringer, R. L., Johnston, P. A., & Tickner, J. (1998). The precautionary principle: protecting against failures of scientific method and risk assessment. Marine Pollution Bulletin, 36912), 939-950.

Sasikumar, K., & Krishna, K. G. (2009). Solid Waste Management. Asoke K. Ghosh: New Delhi

Sawell, S. E., Heitherington, S. A. and Chandler, A. J. (1996). An overview of municipal solid waste management in Canada. *Waste Management*, *16*(5/6), 351-359.

Schwarz, S., C., & Brunner, C. R. (1983). Energy and Resource Recovery from Waste. Noyes Data Corporation: New Jersey

Seadon, J. K. (2006). Integrated waste management - looking beyond the solid waste horizon. *Waste Management*, *26*(12), 1327-1336.

Seasons M. (2003). 'Monitoring and evaluation in municipal planning: Considering the realities. Journal of American Planning Association 69 (4): 430-40

Shah, A. (2008). "Structural Adjustment – A Major Cause of Poverty". Global Issues, available at www.globalissues.org/article. accessed January 16, 2009.

Shenton, A. K. (2004). Strategies for ensuring trustworthiness in qualitative research projects. Education for Information, 22, 63-75. IOS Press

Sicular, D. T. (1992). Scavengers, Recyclers and Solutions for Solid Waste Management in Indonesia. Centre for Southeaste Asian Studies Monograph, no 32. Berkeley: University of California

Silitshena, R. M. K. (1996). "Urban environmental management and issues in Africa south of the Sahara". In sustaining the future: Economic, Social and Environmental Change in Sub-Saharan Africa; Benneh, G Morgan, B., and Uitto, J., (eds). United Nations University Press: Tokyo 100-1222

Simon, H. (1976) 'Administrator behaviour: A study of decision making processes in administrative organizations'. New York: Free Press

Sinha, K. (1993). Partnership in solid waste collection: Malaysian Experience. *Regional Development Dialogue 14 (3). pp 40-49*

Slocombe, D. S. (1993). Environmental planning, ecosystem science and ecosystem approaches for integrating environment and development. *Environmental Management, 17*(3): p. 289-303

Slovic, P. (1987). Perception of risk. Science, 236, 280-285.

Slovic, P. (1993). Perceived risk, trust, and democracy. Risk Analysis, 13(6), 675-682.

Slovic, P. (2001). The risk game. Journal of Hazardous Materials, 86, 17-24.

Smith, D. (1996). *Third Word Cities in Global Perspective: The Political Economy of Uneven Urbanization.* Boulder: Westview Press

Socunya, R., Matias, L., & Lapid, D. (1997). Hospital Waste Management in the Philippines: Two Case Studies in Metro Manila. Urban Waste Expertise Programme, UWEP. The Netherlands.

Soerjani, M. (1984). Present Waste Management in Cities in Indonesia. *Conservation and Recycling,* 7 (2-4) pp. 141-148

Soliman, S., Ahmed, A. (2007). "Overview of Biomedical Waste Management in Selected Governorates in Egypt: A Pilot Study" *Waste Management 27 1920-1923*

Sorenson B., & BREEZE, P. (2009). Renewable Energy Focus Handbook. Elsevier Inc Oxford.

Stanford, J.A. & G.C. Poole, (1996). A protocol for ecosystem management. *Ecological Applications,* 6(3): p. 741-744

Srevenson, M.G. (1996). Indigenous Knowledge in Environmental Assessment. Arctic 49

(3): 278-291

Stapenhurst, F., & Langseth, P. (1997). The Role of Public Administration in Fighting Corruption. *International Journal of Public Sector Management*, 10 (5), 311-330

Stiftel B. (2000). 'Planning Theory'. The National AICP Examination Preparation Course Guidebook, ed. P. Roshi. American Institute of Certified Planners: Washington

Stirling, A. (2001). The precautionary principle in science and technology, In T. O' Riordan, J. Cameron & A. Jordan (Eds.), Reinterpreting the precautionary principle (pp. 35-60). London: Cameron May.

Strauss, A., & Corbin J. (1990). Basics of Qualitative Research: Grounded Theory, Procedures and Techniques. *Newbury Park, Sage* California.

Stren, R. E., and Kjellberg-Bell, J. (1994). Urban Research in he Developing World. Volume 4, Centre for Urban and Community Studies, University of Toronto Press: Toronto

Stren, R. E., and White, R.,R. (1989). African Cities in Crisis: Managing Rapid Urban Growth. Westview: Boulder

Stumpf, M., Ternes, T.A., Wilken, R., Rodrigues, S.V., & Baumann, W. (1999). Polar drug residues in sewage and natural waters in the state of Rio de Janeiro, Brazil. *The Science of the Total Environment, 225, 135-141*.

Suckling, C.W. (1992). Toxicity, toxicology and nutrition, in Risk: analysis, perception and management, The Royal Society: London. P.35-65

Swatuk, L. (2009). Toward Good Water Governance. Knowledge is Power? Proceedings of the International Symposium on Water for a Changing World. Developing Local Knowledge and Capacity. Delft, The Netherlands.

Syagga, p. (1993). Problems of Solid Waste Management in Urban Residential Areas in Kenya. In J. Malombe (ed). Proceedings of African Research Network for Urban Management Workshop. University of Nairobi, August 20.

Szaro, R. C. (1998). The ecosystem approach: science and information management: issues, gaps and needs. Landscape and Urban Planning, 40: p. 89-101

Szeftel, M. (1998). Misunderstanding African Politics: Corruption and the Governance Agenda

Tamplin S., Davidson, D., Powis, B & O'leary, Z. (2005). Issues and options for the safe destruction and disposal of used injection materials". *Waste Management* 25: 655-665.

Talyan, V., Dahiya, R., & Sreekrishnan T. (2008). State of municipal solid waste management in Delhi, the capital of India. *Waste Management 28, 1276-1297*

Tewdwr-Jones, M., & Allmendinger, P. (1998). 'Deconstructing Communicative Rationality: A Critique of Habermasian Collaborative Planning'. Environment and Planning A 30(11): 1975-1989).

Theobald, R. (1990). Corruption, Development and Underdevelopment. London: Macmillan

The Presidential/Congressional Commission on Risk Assessment and Risk Management. (1997). Framework for environmental health risk management: final report, volume 1. Retrieved June 12, 2008

Turner, B. (1994). The future for risk research. *Journal of Contingencies and Crisis Management*, 2(3), 146-156.

UNCHS (1999). Infrastructure Privatization in East Africa. Research Report, Nairobi Kenya

United Nations Educational, Scientific and Cultural Organization, Paris
United Nations general Assembly. (2000). "Solving the Puzzle: The Ecosystem Approach and Biosphere Reserves., Report of the United Nations conference on environment and development (No. A/CONF. 151/26 Vol. I). Rio de Janeiro.

United Nations general Assembly. (1992). Report of the United Nations conference on environment and development (No. A/CONF. 151/26 Vol. I). Rio de Janeiro.

United Nations Statistics Department (2009). Hazardous Waste Generation. Retrieved June 2010 from www.unstats.un.org

US Department of Health and Human Services, Agency for Toxic Substances and Disease Registry. (1990). The Public Health Implications of Medical Waste: A Report to Congress. Atlanta, GA.

Visaria, P. (1997). Urbanization in India: An Overview. In Urbanization in Large Developing Countries: China, Indonesia, Brazil and India. Jones, G.W., & Visaria, P (eds). Clarendon Press, pp. 266-288

Wagner, T.P. (1999). The complete guide to the hazardous waste regulations. RCRA, TSCA, HMTA, OSHA and Superfund. John Wiley and Sons: New York

Walsh D., & Lafluer R. (1995). *"Landfills in New York City: 1844-1994" Ground Water,* 33 (4): 556-5

Waltner-Toews, D., & Kay, J. (2005). The Evolution of an Ecosystem Approach: the diamond Schematic and Adaptive Methodology for Ecosystem Sustainability and Health". *Ecology and Society,* 10(1):38

Wang, H., & Nie Y. (2001) "Remedial Strategies for Municipal Solid Waste Management in China" *Technical Paper. Journal of Air and Waste Management Association,* 51: 264-272. Washington: Island Press.

Warren, D. M. (1990). Indigenous Knowledge Systems and Development. Seminar Series on Sociology and Natural Resource Management. Washington D.C.: The World Bank

Weigal, S., Berger, U., Jensen, E., Kallenborn, R., Thoresen, H., & Huhnerfuss, H. (2004). Determination of selected pharmaceuticals and caffeine in sewage and seawater from Tromso/Norway with emphasis on ibuprofen and its metabolites. *Chemosphere, 56, 583-592*

Wekwete, K.H. (1995). Planning Law in Sub Saharan Africa: A focus on the Experiences in Southern and Eastern Africa. *Habitat International.* 19(1)L 13-28

Werlin, H. (1994). Revisiting Corruption: With a New Definition. International Review of Administrative Sciences, 60, 547-558.

Weterings, R. A. P. M., & Van Eijndhoven, J. C. M. (1989). Informing the public about uncertain risks. *Risk Analysis,* 9(4), 473-482.

Wilson D.C. & Nair, C. (1992). Solid Wwaste Management in Developing Countries. In Waste Management in the Coastal Areas of the ASEAN Region: The Roles of Governments, Banking Institutions, Donor Agencies, Private Sector and Communities. Thia-Eng, C. & Garces, L (eds). Proceeding of the Conference on Waste Management in the ASEAN Regions, Singapore, 1991

Wingspread Conference on the Precautionary Principle. (1998). Wingspread Statement. Retrieved October 24, 2003, from http://www.sehn.org/wing.html

World Bank**.** (2006). "Upgrading of Low Income Settlements: Country Assessment Report: Ghana" *www.worldbank.org/urban/upgrading/ghana.html.* accessed July, 2008

World Commission on Environment and Development. (1987). Our Common Future, WCED. Oxford University Press: Oxford.

World Health Organization. (2007). "Wastes from Healthcare Activities" Fact sheet No 253. November 2007 accessed April, 2008

Wrbitzky, R., Goen, T., Frank, F., & Angerer, J. (1995). "Internal exposure of waste incineration workers to organic and inorganic substances" International *Archives of Environmental health, 68, 13-21*.

Zhu, D., Asnani, P., Zurbrugg, C., & Mani S. (2008). Improving Municipal Solid Waste Management in India: A Sourcebook for Policymakers and Practitioners. The World Bank, Washington D.C.

Appendix A: Survey Questionnaire

Title of Research: Biomedical Pollutants and Urban Waste Management in the Accra Metropolitan Area, Ghana: **A** Framework for Urban Management of the Environment (FUME)

Researchers Name: Jeffrey N.T. Squire, PhD Candidate, School of Planning. University of Waterloo

Section 1: (Please circle one of the answers that best apply to you.

1. Are you?
   (a) male
   (b) female

2. You are between the ages of:
   (a) 18-29
   (b) 30-39
   (c) 40-49
   (d) 50 and over

3. What is your educational background?
   (a) Primary/elementary
   (b) secondary/technical/vocation
   (c) Polytechnic
   (d)University

Section B: Waste Management in Accra (Please provide your opinion on the following questions by circling one of the answers provided.

1. How would you rate general waste management practices in Accra?

   a. Excellent
   b. Very good
   c. Good

d. Satisfactory
e. Poor
f. Very poor

2. How satisfied are you with waste management practices in Accra?

a. Very satisfied
b. Satisfied
c. Somewhat satisfied
d. Not satisfied

3. Are you aware of any public documents relating to waste management in Accra?

(a) Yes, I am aware
(b) No, I am not aware
(c) I am somewhat aware

4. Have you ever participated or invited to participate in a waste management planning process?

(a) Yes
(b) No

5. Have you ever employed the services of the informal sector for waste collection?

(a) Yes
(b) No

6. Which of the following service providers do you trust to do a better job with waste management in Accra?

(a) The Accra Metropolitan Authority
(b) Private Contractors
(c) The Informal Sector (Kaya-Boorlas)
(d) None of them
(e) All of them

7. How would you rate waste collection services in Accra?
   (a) Excellent
   (b) Very Good
   (c) Good
   (d) Poor
   (e) Very Poor
   (f) Deplorable

8. How would you rate the transportation of wastes in Accra?
   (a) Excellent
   (b) Very Good
   (c) Good
   (d) Poor
   (e) Very Poor
   (f) Deplorable

9. How would you rate waste storage practices in Accra?
   (a) Excellent
   (b) Very Good
   (c) Good
   (d) Poor
   (e) Very Poor
   (f) Deplorable

10. How would you rate waste disposal practices in Accra?
    (a) Excellent
    (b) Very Good
    (c) Good
    (d) Poor
    (e) Very Poor
    (f) Deplorable

11. Who would you say is responsible for the current state of waste management in Accra?
    (a) The AMA
    (b) Private Contractors

(c) The Informal Sector
(d) None of the above
(e) All of the above

12. Which of the following service providers do you think is doing a better job in terms of waste management in Accra?

(a) The Accra Metropolitan Authority
(b) Private Contractors
(c) The informal Sector (Kaya-boorlas)
(d) None of them
(e) All of them

13. Do you think ineffective waste management practices constitute a threat to the environment?

(a) Yes
(b) No

14. If your answer to question 7 is yes, what are some of the risks? Please list.

15. Do you think ineffective waste management practices constitute a threat to public health?

(a) Yes
(b) No

16. If your answer to question 7 is yes, what are some of the risks? Please list.

Appendix B: Semi-Structured Interview Questions

A1: Interview Questions for BMW generators (Frontline Staff)

1. Do you have to follow any guidelines when dealing with the wastes generated in this facility?
2. Are you aware of national or local policies governing the management of biomedical wastes?
3. Does your healthcare facility (HCF) provide training for staff with regards to the handling, storage, transportation, treatment and disposal of biomedical wastes?
4. In your HCF do you separate infectious wastes from non infectious wastes?
5. In your facility do you use colour-coded bags for storing wastes?
6. In your facility, do you have special containers for collecting sharp instruments such as needles, blades and scalpels?
7. In your facility do you have a secured room for storing infectious wastes?
8. How do you transport wastes internally in your facility?
9. When storing waste in your facility at what level do you fill your container?
10. Have you ever been injured while using sharp objects such as needles, blades and knives?
11. In your facility how do you dispose of infectious wastes including blood, body fluids and items saturated with blood or body fluids?
12. In your facility how do you dispose of hazardous wastes such as left over drugs and vaccines?
13. Overall, are you satisfied with the way biomedical waste is managed in your facility?
14. Do you have an environmental management department in this facility?
15. How would you rate waste management practices in your facility?
16. Do you think current practices need improvement? Why or why not?
17. Are you aware of any risk(s) posed by biomedical waste to the environment?
18. Are you aware of any risks posed by biomedical waste to human health?

19. Who do you think must take the lead in planning and designing effective biomedical waste management practices?
20. What are some of the challenges you face in the management of wastes generated in your facility?
21. Do you view training as an essential component of BMWM?
22. Finally, is there anything you would like to add to the interview that hasn't been addresses?

A2: Interview Questions for BMW generators (Administrators)

1. When managing the wastes generated in this facility, do you have to follow any local or national guidelines or regulations?
2. Is it possible to have a look at existing guidelines?
3. How do you dispose of infectious and hazardous wastes in this facility?
4. Do you have an onsite incinerator?
5. Do you bury waste in this facility?
6. Do you treat infectious and hazardous BMW prior to final disposal? If so how?
7. Do you provide training for your staff with regards to the handling, storage, treatment, transportation and disposal of BMW?
8. Would you say BMWM practices in this facility are environmentally friendly?
9. In this facility do you return expired drugs to the manufacturer?
10. Does this facility have an environmental management office or facility?
23. Are you aware of any risk(s) posed by biomedical waste to the environment?
11. Are you aware of any risks posed by biomedical waste to human health?
12. Do you have an environmental management department in this facility?
13. How would you rate waste management practices in this facility?
14. Do you think current practices need improvement? Why or why not?
15. Do you think infectious and hazardous wastes generated in this facility pose a risk to the environment? If so in what ways?
16. Do you think infectious and hazardous wastes pose a risk to human health? If so in what ways?
17. Who do you think must take the lead in planning and designing effective biomedical waste management practices?
18. What do you think are some of the factors militating against effective waste management practices in Accra?
19. In what ways do you think the current situation can be improved?

20. When planning and making decisions about waste management does the AMA consult and collaborate with you?
21. Would you like the AMA to consult and collaborate with you when planning and making decisions about the management of BMW?
22. Is your outfit well equipped to manage BMW effectively and efficiently? If yes in what ways, if no what are the challenges?
23. Do you have a mortuary in this facility? If yes, how is waste water from the mortuary disposed?
24. Finally, is there anything you would like to add to the interview that hasn't been addresses?

A3: Interview Questions for Waste Managers: (Administrators)

1. Does your company collect wastes from hospitals, laboratories and other human and animal healthcare facilities?
2. In the discharge of your duties do you have to follow any national and/or local guidelines, regulations and policies?

Is it possible to have a look at existing guidelines?

3. Would you consider existing policies as effective or ineffective? Why and/or why not?
4. Does your company provide special training for employees with regards to the handling, storage, transportation, treatment and disposal of healthcare waste?
5. Does your company provide protective clothing when handling infectious and hazardous wastes?
6. Does your company have specially designated vehicles for transporting BMW?
7. Where does your company dispose wastes from healthcare facilities, research institutions and laboratories?
8. Do you know if waste disposal sites have special provisions for the management of BMW?
9. How does your employees transport wastes from healthcare facilities (HFCs) to waste disposal trucks?
10. Where do you dispose the wastes collected from healthcare facilities?
11. Does your company treat infectious wastes prior to final disposal?
12. Do you think BMW poses a threat to the environment?
13. Are you aware of the risks posed by hospital wastes to the environment?
14. Does your company take steps to ensure that some of these risks are minimized?
15. Do you think current BMWM practices in your company need improvement? Why or why not?
16. When planning and making decisions about waste management does the AMA consult and/or collaborate with you?
17. Would you like the AMA to consult and collaborate with you when planning and making decisions about the management of BMW?

18. Finally, is there anything you would like to add to this interview?

A4: Interview Questions for Waste Managers: (Frontline staff)

1. Do you collect wastes from hospitals, laboratories and other human and animal healthcare facilities?

2. Are you provided with any special training with regards to handling infectious wastes?

3. Do you use protective clothing when handling infectious wastes?

4. How full do HFCs fill their waste storage containers?

5. How do you transport wastes from healthcare facilities to your truck?

6. Where do you dispose the wastes collected from healthcare facilities?

7. Do you treat such wastes before disposal?

8. Do you think BMW poses a risk to the environment? If so in what ways?

9. Do you think BMW poses a risk to human health? If so in what ways?
9. Do you think current practices needs to be improved? If so how and if not why?
10. Finally, is there anything you would like to add to this interview?

A5: Interview Questions for National Level Decision-Makers

1. Does the government have a framework for managing biomedical wastes?
2. If yes, would you say such policies are working?
3. How do you measure success?
4. Are there enforcement mechanisms in place to check compliance with policy?
5. If there is no policy, to what extent does existing national environmental policy address waste management?
6. In what ways is the government assisting the AMA with biomedical waste management service delivery?
7. Suppose the AMA propose a 1% waste management tax to defray the cost of biomedical waste management service delivery, would you support such an initiative?
8. In what ways do you think the government can assist the AMA in the provision of biomedical waste management service delivery?
9. When planning and making decisions about waste management does the AMA consult and/or collaborate with your department?
10. What do you think about the idea of collaboration among major stakeholders when planning and implementing waste management decisions?
11. Is your outfit well equipped to manage BMW effectively and efficiently? If yes in what ways, if no what are the challenges? Do you think waste management institutions are capable of carrying out their responsibilities in an effective manner?
12. In what ways do you think the government can help the AMA in planning and implementing feasible strategies for managing BMW?
13. As a supplement to government support, what do you think about the idea of the AMA acquiring bank loans to assist in their operations? Such loans will be paid for by a 1% waste management tax imposed on residents.
14. Finally, is there anything you would like to add to this interview

A6: Interview Questions for Local Level Decision-Makers

1. Does the AMA have a policy governing the management of wastes generated in healthcare facilities, research institutions and laboratories?
2. Does the AMA have policies governing the management of waste generated in veterinaries and other animal healthcare facilities?
3. Do you think that existing policies are working?
4. How do you measure success?
5. Do you do periodic assessment of existing policies to check whether or not such policies are working? If no why and if yes, what are the results of most recent assessments? Can I have access to the results?
6. Are there any enforcement mechanisms in place to ensure compliance with policy?
7. Would you say existing enforcement mechanisms are working?
8. What areas do you think need improvement?
9. In what ways do you think the national government can help to improve the current situation?
10. What do you think about the idea of imposing a 1% waste management tax on residents to replace the current arrangement where residents pay directly to the private waste management contractors?
11. What do you think about the idea of the AMA having full economic autonomy to acquire loans for waste management?
12. Are you aware of the risks posed by BMW to the environment?
13. Does the AMA have a sanitary, engineered landfill for waste disposal?
14. Does the AMA have a properly functioning incineration system?
15. Are you aware of the risks posed by BMW to human health?
16. In what ways do you think generators of BMW can assists the AMA with regards to the management of BMW?

17. The precautionary principle states that "when an activity raises threats of harm to the human health or the environment, precautionary action should be taken even if some cause and effect relationships are not fully established scientifically" Do you agree or disagree? Why?
18. Do you think the precautionary principle must be used as a framework for formulating BMWM policies?
19. In general what do you think are some of the factors militating against waste management in Accra?
20. How do you think such factors can be addressed?
21. To what extent does population growth and urbanization impact the generation and management of waste and more specifically, BMW?
22. When planning and making decisions about waste management does the AMA consult with all major stakeholders?
23. Do you think there is a need for collaboration and integration of stakeholder needs when planning and making decisions about waste management service delivery?
24. I have a series of scenarios I want to run by you and I want you to give me your opinion.
25. In order for a BMWM framework to be feasible, there must be major improvements in waste management service delivery in general. Do you agree or disagree?
26. In what ways do you think waste management service delivery can be improved?
27. What do you think about the idea of incorporating waste management in the elementary school curriculum as a way of fostering responsible management practices?
28. In what ways do you think the mass media can contribute to raising awareness about effective waste management practices?
29. Do you think it is a good idea to include convicted prisoners in waste management service delivery as a way of rehabilitation and also curtailing labour costs?

30. Is your outfit well equipped to manage BMW effectively and efficiently? If yes in what ways, if no what are the challenges?
31. Finally, is there anything you will like to add to this interview?

Appendix C: Verbal Statement, Consent Form & Contact Sheet

B1: Verbal Statement

My name is Jeffrey Squire and I am a PhD candidate at the school of Planning, University of Waterloo. I am currently in Ghana conducting research on the management of biomedical waste as part of my PhD dissertation. In this regard, I will like to ask you a few questions pertaining to the subject. This interview will take approximately 1 to 2 hours. The research has been reviewed and approved by the Human Participants Research Committee on behalf of the University of Waterloo

Your participation in this interview is voluntary and you have the right to withdraw your participation at any time. In case you decide to withdraw from this interview before it is over, all information and documents that you provided during your participation will be destroyed. You also have the right not to answer questions if you choose.

I will keep any information you provide to me during this interview confidential and you will also remain anonymous. The information provided in this interview will be kept for a period of three (3) years, after which it shall be destroyed.

In case you have any questions regarding this process, please feel free to contact the following person and office.

Office of Research Ethics
University of Waterloo
Waterloo, Ontario
Phone 519-555-4567

B2: Consent Form

I grant permission for Jeffrey Squire to use information that I provide to him through interviews, observations, document analysis, and/or questionnaires. I understand that my participation is voluntary and I reserve the right to discontinue involvement in the project at any time.

I understand that anonymity will be granted to me unless I specifically request that my identity be revealed.

I understand that the information I give will be included in his PhD dissertation at the School of Planning, University of Waterloo. I also understand that the information I provide may be included in any journal, books or academic resources that the researcher is involved with.

I am fully aware of the nature and extent of my participation in this project as stated above. I hereby agree to participate in this project. I acknowledge that I have received a copy of this consent statement.

Name of Participant (Print):

Signature:

Date:

B3: Contact Sheet

Researchers Name: Jeffrey Squire

ADDRESS: 200 University Avenue West, Waterloo, Ontario

PHONE:

Home: 416-879-2443

EMAIL: jnsquire@uwaterloo.ca

DATE:

Appendix D: List of interviewee numbers, stakeholder group, professional affiliation and job area for identification purposes

Interviewee #	Stakeholder Group	Affiliation	Job Area
1	Healthcare Provider	Private	Physician
2	Healthcare Provider	Private	Administrator
3	Healthcare Provider	Government	Physician
4	Healthcare Provider	Private	Nursing
5	Healthcare Provider	Government	Technician
6	Waste Management Service Provider	Private	Administrator
7	Waste Management Service Provider	Private	Technician
8	Waste Management Service Provider	Private	Engineering
9	Waste Management Service Provider	Private	Frontline Staff
10	Waste Management Service Provider	Private Informal Sector	Frontline Staff
11	Local Government	Government	Senior level
12	Local Government	Government	Senior Level
13	Local Government	Government	Senior Level
14	Local Government	Government	Junior Level
15	Local Government	Public	Labourer
16	Local Government	Government	Senior Level
17	Local Government	Public	Driver
18	Central Government	Government	Nursing
19	Central Government	Private	Nursing
20	Central Government	Government	Technician
21	Central Government	Private	Technician
22	Environmental/Pollution Management	Government	Senior Level
23	Healthcare Provider	Private	Administrator
24	Waste management	Private/Informal Sector	Waste Courier
25	Waste management	Private	Frontline staff