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12th International Post-Graduate Research Conference 2015
Proceedings

MediaCityUK
10-12 June 2015

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ID 121

An Overview of Municipal Solid Waste Management in Developing and Developed Economies: Analysis of Practices and Contributions to Urban Flooding in Sub-Saharan Africa.

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Abstract

Different natural and anthropogenic factors have contributed to increased flood events in recent times. Studies have noted the impact of municipal solid waste management (MSWM) practices on increased flooding. Increases in population, economic growth and rapid urbanisation, especially in developing countries, have led to increased waste production. Despite economic growth, countries in the Southern hemisphere are struggling to cope with the levels of waste generated in their cities. This paper presents global differences in waste generation, composition, legislation and general practices based on existing literature. An understanding of the relationship between MSWM practices and urban flood risk is significant in order to save lives, properties and reduce the direct and indirect effects of environmental degradation. This paper reviews the various MSWM practices and critically studies the constraints and challenges in Nigeria. Nigeria, the most populous African country, the largest economy in Africa and the 26th-biggest economy in the world has a history of flooding and unsustainable waste management practices. This research reveals a gap in knowledge about the contribution of MSWM practices to urban flood risk, and will act as the basis for future research around their relationship.

Keywords:

cities, developing countries, municipal waste, Nigeria, urban floods

1. Introduction

Across all continents, flood events have increased in recent years from a variety of causes including changes in weather events but equally from activities relating to urbanisation (Jha *et al*., 2011). Rapid urbanisation, climate change, increased variation in precipitation and poor town planning (construction of informal settlements near floodplains, rivers and drainage channels) are some other reasons given by researchers for increased cases of flooding.

Among the identified anthropogenic factors, researchers (Boadi and Kuitunene, 2003; Bras *et al*., 2009; Muñoz-Cadena *et al*., 2009; Dodman *et al*., 2011; and Lamond *et al*., 2012) have observed waste frequently leads to blockages in drainage and watercourses. This causes practicable negative effects on the environment, in particular urban pluvial flooding, pollution by emissions into surface water and groundwater, and the resulting risks to human health and property. Blockages of urban drainage systems by wastes increases frequency and severity of flood events, and are a particular difficulty in developing countries (Lamond *et al*., 2012).

World Bank (2012) estimates municipal solid waste (MSW) generation levels to double by 2025. It is necessary to investigate how sub-Saharan African (SSA) cities would cope with population growth, rapid urbanisation and industrialization which are the causative factors for increased levels of waste production. Hence, this paper considered municipal solid waste management (MSWM) in Nigeria, a developing country in SSA by studying existing literatures, policies and data. Rapid urbanization especially in low-income countries includes the rapid growth of cities and metropolitan areas (Zurbrügg, 2002).

Article 3 (1) of the 2008 Waste Framework Directive (Directive 2008/98/EC) defines "waste" as: "…any substance or object which the holder discards or intends or is required to discard…" (DEFRA, 2012). Solid waste is any unwanted or discarded material that is not liquid or gas (Miller, 1997). MSWM is the collective process of sorting, storage, collection, transportation, processing, resources recovery, recycling and disposal of waste in urban areas (Abila and Kantola, 2013; Ogwueleka, 2009).

Municipal solid waste in this research includes residential, industrial, commercial, institutional, municipal, and construction and demolition waste in conformity with United Nations (1992). Waste disposed by individuals, community and non-governmental groups instead of local authorities are included as MSW in this study.

MSWM is a major problem in most developing countries (Parrot *et al*., 2009). This paper investigates waste management legislation and practice in Nigerian cities because studies (Lamond *et al*., 2012; Babayemi and Dauda, 2009; and Onwughara *et al*., 2010) have indicated that inadequate infrastructure for MSWM presents a challenge to flood risk management. In the context of this research, the relationship between MSWM practices and flood risk management (FRM) was investigated in order to understand the contributions of MSWM practices to increased flood events.

2. Global Waste Generation

0.49 billion tons of MSW was generated in 1997 with an estimated annual growth rate of 3.2–4.5% in developed nations and 2–3% in developing nations (Suocheng *et al*., 2001). World Bank (2012) estimated that 1.3 billion tonnes of waste are produced each year which is expected to increase to approximately 2.2 billion tonnes per year by 2025. MSW generation is influenced by the level of economic development, population demographics, industrialization, public habits and local climate. Petts and Edulijee (1994) agreed that the state of the economy influences waste generation.

UN-HABITAT (2010a) agreed that urban population now exceeds those residing in rural areas across the globe. Urban residents produce about twice as much waste as their rural counterparts (World Bank, 2012). OECD countries produce almost half of the world's waste, while Africa and South Asia produce the least waste (Figure 1) (World Bank, 2012). This contrast in waste volumes could be attributed to differences in socio-economic status and socio-cultural attitude towards solid waste management.

China is responsible for 70% of 270 million tonnes of waste generated each year in East Asia and the Pacific Region, and overtook the United States of America in 2004 as the world's largest waste generator (World Bank, 2012). World Bank (2012) estimates that in 2030, China will likely produce twice as much MSW as the United States of America (Table 1). These estimates of increased waste generation in China could be connected to higher income level, high rate of urbanization and population.
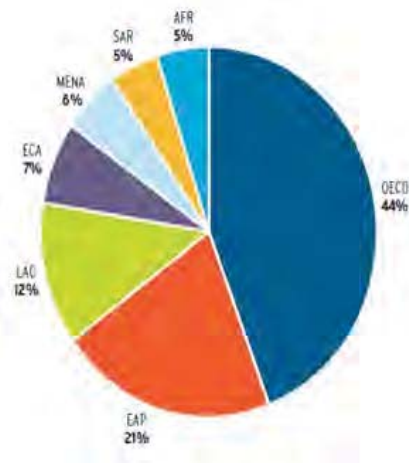
AFR: Africa region here refers to sub-Saharan African
EAP: East Asia and Pacific region
ECA: Europe and Central Asia region
LAC: Latin America and the Caribbean region
MENA: Middle East and North Africa region
OECD: Organisation for Economic Co-operation and Development
SAR: South Asia region

Fig 1: Current Waste Generation by Regions (World Bank, 2012)

Table 1: Waste Generation Projections for 2025 by Regions (World Bank, 2012)

Region	Current Available Data			Projections for 2025			
	Total Urban Population (millions)	Urban Waste Generation		Projected Population		Projected Urban Waste	
		Per capita (kg/capita/day)	Total (tons/day)	Total Population (millions)	Urban Population (millions)	Per capita (kg/capita/day)	Total (tons/day)
AFR	260	0.65	169,119	1,152	518	0.85	441,840
EAP	777	0.95	738,958	2,124	1,229	1.5	1,865,379
ECA	227	1.1	254,389	339	239	1.5	354,810
LCR	399	1.1	437,545	681	466	1.6	728,392
MENA	162	1.1	173,545	379	257	1.43	369,320
OECD	729	2.2	1,566,286	1,031	842	2.1	1,742,417
SAR	426	0.45	192,410	1,938	734	0.77	567,545
Total	2,980	1.2	3,532,252	7,644	4,285	1.4	6,069,703

Cities in India generate high proportion of wastes due to greater economic prosperity and increased urban population. Mumbai generates 8,000 tonnes per day, Delhi 6,000 tonnes per day; Chennai 4,000 tonnes per day and Hyderabad produce 2,200 tonnes per day (Chattopadhya et al., 2009). World Bank (2012) attributed the highest per capita rates of wastes produced in Latin America and the Caribbean to the tourism industry and a complete accounting of all wastes generated. Manaf et al. (2009) highlighted the relationship between population growth and solid waste generated in Peninsular Malaysia.

The proportion of Africa's population living in urban areas increased from 24% in 1970 to 40% in 2010, and is expected to reach 50% by 2030 (UN-HABITAT 2010a and 2010b). SSA generates an estimated 62 million tonnes of waste per year (World Bank, 2012). Urbanization is jump-starting industrialization and the 40 % of Africa's population that now live in cities, produces 80 % of its GDP (UN-HABITAT, 2010b). UN-HABITAT (2010b) cited 61.7% of the urban population of SSA live in slums where there is an absence of social amenities. Smit and

Parnell (2012) agreed that the growth of 'slums' is the most tangible manifestation of Africa's urban malaise.

The above listed statistics indicate that growth in urban areas is in tandem with increase in population and waste generation. It is evident that there is unsustainable population growth in urban areas in most developing countries which has led to increased levels of waste production. Waste generated in cities vary in composition and volume from location to location and within a location.

3. Global Waste Composition

Composition of waste affects the collection, storage, and transportation of wastes. Knowledge of waste composition is important in order to implement the most appropriate treatment and disposal process (McDougal *et al*., 2001). Wastes generated in developing cities are heavier, wetter and more corrosive than those from developed cities (Ogwueleka, 2009). This could inhibit the effectiveness of compaction vehicles used for collection and transfer of waste. The developed cities of the world are able to balance the negative impacts of urbanisation, industrialization and population growth using environmental legislation and appropriate mitigation.

Waste generation rates ranged from 0.66kg/cap/d in urban areas to 0.44kg/cap/d in rural areas of developing countries as opposed to 0.7-1.8kg/cap/day in developed countries (Cointreau, 1982). Wastes generated in developing countries have high organic content (more than 50%) and a low energy value (3,350–4,200 kJ per kg) (CPHEEO, 2000). The USA (65%) and Western Europe (48%) generate higher quantities of paper and plastics compared to those from developing countries (IGES, 2001). The largest generator of waste in the United Kingdom in 2004 was from the construction and demolition industry (32%) (Fischer *et al*., 2011).

3.1. Waste Generation and Composition in Nigeria

Population is distributed at 48.3% urban and 57.7% rural and population density at 139 people per square km in Nigeria (Ogwueleka, 2009). Lagos grew from 252,000 in 1952 to 10.5 million people in 2010, and is projected to be 15 million by 2020 (UN-HABITAT, 2010b). 25 million tonnes of MSW are generated annually in Nigeria (Ogwueleka, 2009). The evidence above suggests that due to increased urbanisation and population, waste generation is likely to accelerate more in SSA countries such as Nigeria than other parts of the world.

Table 2 below highlights the volumes and densities of waste generated in 9 major cities in Nigeria. The density of solid waste in Nigeria ranged from 250 kg/m3 to 370 kg/m3 higher than those in developed countries (Ogwueleka, 2009). Waste management challenges in Abuja Municipal Area are linked to population growth and the high number of construction projects (Oyeniyi, 2011). 2,000 Council workers in Abuja are faced with considerable challenges on MSW collection and disposal especially in sub-urban districts and clusters of satellite settlements (Oyeniyi, 2011).

Nsukka (waste density 370 Kg/m^3), a city surrounded by agrarian areas is significantly different to the more cosmopolitan city of Lagos (waste density 294 Kg/m^3) (Table 2). Lagos State Waste Management Authority (LAWMA) classified majority of the waste types generated and collected in Lagos into: vegetable matter, putrescibles, paper, textiles, metal, plastics, glass, grits, miscellaneous, inert, tyres and others (Adewole, 2009). However, experiential knowledge indicates water packaged in plastic sachets (*pure water*) for human consumption, polyethylene shopping bags and plastic drink bottles constitute a compelling source of waste in Nigerian cities.

Table 2. Urban Solid Waste Generation in Nigeria (Ogwueleka, 2009).

City	Population	Agencies	Tonnage (monthly)	Density (Kg/m³)	Kg/capita/ day
Lagos	8,029,200	Lagos Waste Management Authority	255,556	294	0.63
Kano	3,248,700	Kano State Environmental Protection Agency	156, 676	290	0.56
Ibadan	307, 840	Oyo State Environmental Protection Commission	135,391	330	0.51
Kaduna	1,458, 900	Kaduna State Environmental Protection Agency	114, 433	320	0.58
Port Harcourt	1, 053, 900	Rivers State Environmental Protection Agency	117, 825	300	0.60
Makurdi	249,000	Urban Development Board	24, 242	340	0.48
Onitsha	509, 500	Anambra State Environmental Protection Agency	84, 137	310	0.53
Nsukka	100, 700	Enugu State Environmental Protection Agency	12,000	370	0.44
Abuja	159, 900	Abuja Environmental Protection Agency	14, 785	280	0.66

3.2. Waste Legislation

Effective waste legislation is not only beneficial to citizens and governments but contributes to economic advancement while protecting the environment. Differences in MSW legislation between developed and developing countries were analysed using the United Kingdom and Nigeria as case studies. Nigeria is Africa's largest economy, fastest urbanizing and most populated country (Bloomberg, 2014 and United Nations, 2014), with chronic MSWM problems. On the contrary, the UK has significantly reduced landfilled MSW from 80 % in 2001 to 49 % in 2010 (Watson, 2013).

In 2001, before the EU Landfill Directive came into effect in England and Wales, around 84 million tonnes of waste was sent to landfill, which means a 23% reduction when compared to 65 million in 2007 (DEFRA, 2008). Municipal waste sent to landfill has decreased from 25 million tonnes in 2010 to 20 million tonnes in 2012 (DEFRA, 2013). These reductions in waste volume are connected to the enforcement of the European Union Waste Framework Directive.

EU Waste Framework Directive, revised in 2008, streamlines waste management in the Member States in order to limit the generation of waste and to optimise the organisation of waste treatment and disposal (EC, 2010). EU policies aim to reduce the environmental and health impacts of waste and improve Europe's resource efficiency (EC, 2010). Prevention of wastes; preparation for re-use; recycling of wastes; other recovery methods such as energy recovery; and waste disposal in descending order is the preferred hierarchy of options in the EU policy.

Developing countries including Nigeria viewed global environmental concerns in the 1970's with suspicion (Nwufo, 2010). Nigeria and Italy were engaged in a diplomatic dispute due to the dumping of 8,000 drums of hazardous waste in Koko, (a small Nigerian port) by an Italian ship. Aftermath of this incident changed the way wastes were viewed in Nigeria, prompting the development of the national policy on the environment and enactment of legislations to back it up (Ogbodo, 2009).

Federal Environmental Protection Agency (FEPA) Act enacted by Decree 55 of December 30th 1988 and Decree 59 (amended) of 1992 was created and charged with the administration and enforcement of environmental law in Nigeria (NESREA, 2014). Prior to this incident, environmental legislation was covered under unrelated laws on distinct topics, such as, "wild animals," "sanitation," "National Parks," and "domestic personal hygiene (Ogbodo, 2009).

The National Environmental Standards and Regulations Enforcement Agency (NESREA) established by section 20 of the 1999 Nigerian Constitution in 2007 is responsible for enforcing environmental laws, guidelines, policies, regulations and standards (Federal Ministry of Environment, 2015). There are 11 laws and regulations used by NESREA to enforce compliance with provisions of the Nigerian Constitution, international agreements, protocols, conventions and treaties on the environment (NESREA, 2014).

3.3. Municipal Solid Waste Collection and Disposal

Certain deficiencies inhibit efficient waste collection, segregation storage and transportation in developing countries. Factors such as nature of local activities, food habits, cultural traditions, socio-economic factors, climatic conditions, and seasons determine the waste components (Chattopadhya *et al*., 2009). Abila & Kantola (2013) cited the connection between ineffective governance, low quality living standards, limited level of environmental awareness and poor domestic waste practices.

Municipal waste management systems in Indian cities are often unscientific and chaotic (Chattopadhya *et al*., 2009). There is ineffective MSWM in most of the developing countries notably the absence or limited level of resource recovery such as formal recycling schemes. Anecdotal evidence suggests that *pure water* sachets contribute to urban pollution in Nigeria due to the absence of formal recycling facilities. Only 8% of the wastes generated in Nigeria are recovered for reuse (Ogwueleka, 2009). Waste scavengers are responsible for collection of recyclable prior to the disposal of the waste in developing countries.

The type, condition and location of collection and disposal facilities influence MSWM practices. Yunus and Kadir (2003) agreed that most of the landfill sites used for MSW in Malaysia are open dumping areas pose serious environmental and social threats. Lack of sanitary landfills means that majority of waste collection and disposal in Kenya do not meet environmentally safe MSW disposal levels (Henry *et al*., 2006). Residents of Ikoyi and Victoria Islands in Lagos cited inadequate waste facilities as their reason for dumping waste in drainage canals (Folorunsho & Awosika, 2000).

Socio-economic, socio-cultural and socio-political factors influence urban waste collection, disposal and treatment. It is common to see outsiders deposit waste in poorer locations considered marginal (Davis, 2006). Friends of the Earth (2004) argue that poorer communities tend to be hit hardest by environmental pollution, by highlighting that 50% of operating municipal waste incinerators in England are located in the most deprived 10% of wards. Despite the relocation of environmental problems away from wealthy locations, citywide and regional environmental degradation, due to a poor MSWM, remains or increases (Zurbrügg, 2002).

Chattopadhya *et al*. (2009) found the collection points in Kolkata, India, are in poor conditions due to a lack of awareness and maintenance. The waste transport system is inefficient due to unreliable vehicles and residents dispose waste haphazardly at the collection points soon after removal of waste (Chattopadhya *et al*., 2009). Unskilled personnel, political interference and economic constraints are obstacles to efficient MSWM in developing countries.

Henry *et al*. (2006) cited that Kenyan politicans pursue the interests of their parties when voting or making decisions. Zurbrügg (2002) listed bureaucratic confusion and delays due to a multitude of agencies and political interference as main challenges to MSWM in Asia. Despite the overlap in MSWM responsibilities between the different levels of governments in Nigeria, LAWMA has improved MSWM within Lagos State but it still falls below the required standard in developed countries.

Zurbrügg (2002) cited public private partnerships (PPP) due to inefficient municipal systems or by pressure from national governments and international agencies as an alternative. Outsourcing of MSWM duties to profit making organisations requires urban authorities to supervise and penalize the companies if required. The successful use of PPP recorded in Chennai, India as noted by Zurbrügg (2002) may not be applicable in other countries. PPP have been introduced by different levels of government in Nigeria with mixed levels of success.

3.4. Urban waste and flood risk

Halley (2001) cited inadequate drainage facilities as the major cause of floods in Africa. Climate change is directly and or indirectly increasing the amount of rain and ice melting that is increasing the amount of runoff (Adetunji and Oyeleye, 2013). Rise in flood risk is connected to the proportional increase of a catchment's impermeable surface area due to urbanisation (Swan, 2010).

Continuous construction of properties on floodplains and low lying coastal areas is a direct consequence of rapid urban growth especially in developing countries. There are questions about the management of wastes generated from these properties in SSA. Due to rapid urbanisation in recent years, many existing waste disposal sites have been encircled by settlements and housing estates (Zurbrügg, 2002).

Certain MSWM practices increases the risk level thereby exposing people to different hazards which promote environmental vulnerability. Uncontrolled dumping of waste in watercourses is a common problem that leads to flooding in Malaysia (Manaf *et al*., 2009). Chattopadhya *et al*. (2009) found that in certain locations in Kolkata (boroughs 11–15), which still have some open space, a large quantity of waste is disposed of in open canals and drains, or dumped into low–lying areas instead being collected.

Understanding the relationship between MSWM practices and flood risk is vital in order to evaluate the contributions of the practices to increased flood events. Accumulation of debris and waste on the streets that is then washed into the drainage system can lead to surface and property flooding. Indiscriminate dumping of uncollected waste in the streets and in drains which mixes human and animal excreta contributes to flooding (Zurbrügg, 2002).

Two-thirds of Lagos residents live in slum communities of different sizes, spanning from clusters to large districts (Morka, 2007). MSW are highly desirable resource in Badia, a large slum. Ajibade and McBean (2014) highlighted the use of waste for flood control in Badia during heavy rains and storm surges. This practice called waste-filling is a cheaper option to sand filling when constructing a foundation for a house and it generates income for garbage-

collectors and unauthorized developers who waste-fill parts of the canal for sale (Ajibade and McBean, 2014).

Waste filling in Badia pollutes the local environment and exposes residents to flood risk because Lagos is a coastal city with a history of flooding due to a low-lying terrain. Environmental vulnerability in Badia is on the increase due to the destruction of natural buffers against flooding, blocked available drainage systems, and increased housing subsidence. Henry *et al*. (2006) cited cases in Kenya whereby Nairobi River and Nairobi Dam were polluted by MSW generated from the nearby slums.

Wastes are usually dumped on roadsides, available open pits, flowing gully water and drainage channels in Nigeria (Babayemi and Dauda, 2009; and Onwughara *et al*., 2010). Residues from waste incineration and wastes deposited in uncontrolled and unregulated landfills/dumpsites are often carried away by urban water runoff thus increasing flood risk. The absence of waste transfer stations makes it difficult to compact wastes thereby exposing them to high winds. Wastes on transit that are dispersed during moderate and high winds, and tropical rain often end up in waterways and canals thereby compromising the natural drainage system.

Developing countries are susceptible to illegal dumping of hazardous wastes which in certain cases end up in watercourses. This could damage water pumping stations meant for flood control thereby clogging storm drains and inland waterways leading to flash floods after heavy precipitation. Olurominiyi (2008) cited the construction of the hazardous waste landfill in Dakar close to the water network. This is a direct hazard to drinking water supply of the estimated 2.5 million residents.

MSW inhibit the natural flow of water, contaminate surface and groundwater. The unreliable nature of the waste fills as a structural base could lead to land and housing subsidence in Badia. Waste sites become a sanctuary for vectors that transmits communicable diseases. An outbreak of diarrhoea in Kenya was traced to a vegetable farm due to MSW dumped upstream which contaminated surface water used for irrigation (Henry *et al*., 2006). Accelerated growth of water hyacinth (*Eichhornia crassipes*) in Lake Victoria was partly connected to MSW disposal (Ecoforum, 2001).

Certain studies have proposed solutions for improving MSWM but have failed to adequately address the source-pathway-receptor link in relation to MSW and flood risk. For instance, Folorunsho & Awosika (2000) recommended a comprehensive drainage rehabilitation plan in order to solve the clogging of the drainage channels in Lagos by MSW. This solution is inadequate and not inclusive because in most informal settlements there is remarkable absence of drainage facilities.

4. Discussion

Evidence from the above literature reveals the contrasting state of MSWM in developing and developed countries. The review identifies that enforcement of MSW legislation is weak and operational policies are outdated and ineffective in many developing countries. Systemic management of waste is challenging in the absence of effective waste legislation (Gertsakis and Lewis, 2003). Appropriate waste legislation could improve MSWM practices in the Southern hemisphere.

State and local governments in Nigeria use legal frameworks to establish environmental agencies such as Lagos State Waste Management Authority (LAWMA) and Abuja Environmental Protection Board (AEPB), for the protection and improvement of the environment within their jurisdictions. These agencies have not solved the problems of MSWM.

Major components of MSW in Nigeria are unclear and the trajectory of MSW composition is likely to change with urbanisation.

The provision of basic services in waste management is an uphill task for many municipalities (Zurbrügg, 2002). The provision of facilities alone would not solve the problems of indiscriminate dumping of waste. A comprehensive understanding of the relationship between MSW and urban flooding is required. Research findings indicate a more complicated relationship than previous works suggests. Neglecting social components and priorities in waste management practices would lead to failure (Dijkema *et al*., 2000; Morrissey and Browne, 2004; and Petts 2000).

Researchers have different opinions on how the awareness, attitude and behaviour of residents towards environmental issues are influenced by demographics. Fortman and Kusel (1990) found that women were more ecologically active than men. Herrera (1992) concluded that both groups did not differ in their environmental values. Young people have been found to litter more than older ones and males more than females and people who are alone litter more than those in groups (Bell *et al*., 2001).

Environmental awareness through education is a non-structural measure that could prepare people to manage urban floods. Preparedness education that emphasizes on keeping drains free of wastes is part of the flood risk mitigation efforts in Mozambique (Jha *et al*., 2011). There is need to investigate if contributions of MSWM to increased flood risk could be minimized by increasing the awareness, improving the attitude and behaviour of residents towards waste. Conclusions were drawn using available literature assessed in this research.

5. **Conclusion**

The purpose of this study was to examine MSWM practices and investigate their contributions to increased flood events. After a critical review of available literature, an understanding of the poor state of MSWM in developing countries was gained and knowledge gap on relationship between MSW and flooding identified. The research agrees with previous studies that neglecting social components and priorities in MSWM practices would lead to failure. There is need for more research to understand why individuals and organisations have failed in adhering to, and enforcing the various waste regulations.

MSWM is at unsatisfactory levels in developing countries despite generating lower quantities of waste. Significant contrast exists in the composition of wastes generated in developed and developing countries. Developed countries are witnessing a reduction in landfilled waste due to effective MSW legislation, provision of necessary facilities and others. Further research would need to investigate if this could be connected to the higher density of wastes generated in developing cities.

Available literature indicates that impacts of increased flood events due to progressive urbanisation are not limited to developing countries but the effects are felt more in these countries in part to poor MSWM. Open dumping of wastes, deposition of wastes in uncontrolled and unregulated landfills, open burning of wastes in unauthorised locations and in landfills increases flood hazards hence promoting vulnerability.

Nigeria has high levels of precipitation especially during the wet season thereby exposing cities such as Lagos that are low lying and highly prone to flooding. The absence of a National Waste Management Plan in Nigeria advances the risk of surface water flooding due to unsustainable MSWM practices in Nigerian cities.

Flooding has a direct impact on the local, regional and national economies. Available research has not provided a clear pathway on how the wastes generated increase the impact of urban floods on individuals, organisations and the environment. Further studies are required to interrogate the knowledge gap particularly on the sources, pathways and receptors of urban floods due to municipal solid waste.

The next stage in this research is to develop a conceptual framework of urban flood risk and municipal solid waste to provide a linkage between them. This would identify critical pathways that can be used to reduce flood impact with emphasis on informal settlements which are particularly a problematic aspect.

References

Abila, B., & Kantola, J. (2013). Municipal Solid Waste Management Problems in Nigeria: Evolving Knowledge Management Solution. *International Journal of Environmental, Ecological, Geological and Mining Engineering, 7*(6), 172-177.

Adetunji, M., & Oyeleye, O. (2013). Evaluation of the Causes and Effects of Flood in Apete, Ido Local Government Area, Oyo State, Nigeria. *Civil and Environmental Research, 3*(7), 19-26.

Adewole, A. T. (2009). Waste Management Towards Sustainable Development in Nigeria: A Case Study of Lagos State. *International NGO Journal, 4*(4), 173-179.

Ajibade, I., & McBean, G. (2014). Climate extremes and housing rights: A political ecology of impacts, early warning and adaptation constraints in Lagos slum communities. *Geoforum, 55*, 76–86.

Babayemi, J., & Dauda, K. (2009). Evaluation of solid waste generation, categories and disposal options in developing countries: a case study of Nigeria. *Journal of Applied Sciences and Environmental Management, 13*, 83-88.

Bell, P. A., Greene, T. C., Fisher, J. D., & Baum, A. (2001). *Environmental Psychology* (5th ed.). California, USA: Wadsworth Group/Thomson Learning.

Bloomberg News. (2014). *Bloomberg.* Retrieved April 8, 2014, from Bloomberg News Web site: http://www.bloomberg.com/news/2014-04-06/nigerian-economy-overtakes-south-africa-s-on-rebased-gdp.html

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

Bras, A., Berdier, C., Emmanuel, E., & Zimmerman, M. (2009). Problems and current practices of solid waste management in Port-au-Prince (Haiti). *Waste Management, 29*(11), 2907-2909.

Central Public Health and Environmental Engineering Organization. (2000). *Manual on Municipal Solid Waste Management.* New Delhi: Ministry of Urban Development, Government of India.

Chattopadhyay, S., Dutta, A., & Ray, S. (2009). Municipal solid waste management in Kolkata, India – A review. *Waste Management, 29*, 1449–1458.

Cointreau, S. J. (1982). Environmental management of urban solid waste in developing countries: a project guide.Urban Development Technical paper No 5. June. Washington, DC: The World Bank.

Davis, M. (2006). *Planet of Slums.* London; New York: Verso.

Department for Environment, Food and Rural Affairs. (2008). *Waste Strategy Annual Progress Report 2007/08.* Retrieved February 15, 2015, from Department for Environment, Food and Rural Affairs Web site: www.defra.gov.uk/environment/waste/strategy/strategy07/index.htm

Department for Environment, Food and Rural Affairs. (2012). *Guidance on the legal definition of waste and its application.* Retrieved February 5, 2014, from Department for

Environment, Food and Rural Affairs Web site:
http://www.defra.gov.uk/environment/waste/legislation/eu-framework-directive/

Department for Environment, Food and Rural Affairs. (2013, November). *Waste and recycling statistics.* Retrieved February 10, 2015, from UK Government Web site:https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/401400/Digest_of_waste_England_2015_-_final.pdf

Dijkema, G., Reuter, M., & Verhoef, E. (2000). A new paradigm for waste management. *Waste Management, 20*(8), 633–638.

Dodman, D., Kibona, E., & Kiluma, L. (2011). Tomorrow is too late: Responding to Social and Climate Vulnerability in Dar es Salaam, Tanzania. Case study prepared for Cities and Climate Change: Global Report on Human Settlements 2011. UN-habitat.

Ecoforum. (2001). Lake Victoria: Economic Lifeline, Regional Toilet.(Water hyacinth prob). *25*(2).

European Commission. (2010). *Being wise with waste:the EU's approach to waste management.* Retrieved February 10, 2015, from European Commission Web site: http://ec.europa.eu/environment/waste/pdf/WASTE%20BROCHURE.pdf

Federal Ministry of Environment. (2015). *Federal Ministry of Environment : Agencies and Parastatals*. Retrieved March 5, 2015, from Federal Ministry of Environment Web site: http://environment.gov.ng/index.php/about-moe/agencies-parastatals/nesrea

Fischer, T., Potter, K., Donaldson, S., & Scott, T. (2011). Municipal Waste Management Strategies, Strategic Environmental Assessment and the Consideration of Climate in England. *Journal of Environmental Assessment Policy and Management, 13*(4), 541–565.

Folorunsho, R., & Awosika, L. (2000). Flood Mitigation in Lagos Nigeria Through the Wise Mangement of Solid Waste: The Case of Ikoyi and Victoria Islands. *UNESCO Environment and Development in Coastal Regions and in Small islands - Coastal Region and Small Island Papers 12: papers*.

Fortman, L., & Kusel, J. (1990). New voices ,old beliefs :forest environmentalism among new and long standing rural residents. *Journal of Rural Psychology*, 214-232.

Friends of the Earth. (2004, January). *Briefing on Incinerators and deprivation.* Retrieved February 10, 2015, from Friends of the Earth Web site: www.foe.co.uk

Gertsakis, J., & Lewis, H. (2003). Sustainability and the Waste Management Hierarchy:A Discussion Paper on the Waste Management Hierarchy and its Relationship to Sustainability pp. 1–15. Melbourne: RMIT University.

Halley. (2001). Impact of 1998 Flood Nutrition and Health. What can we learn from Future Disaster?. Dhaka: Helen Keller International, Bangladesh and Institute of Public Health Nutrition.

Henry, R. K., Yongsheng, Z., & Jun, D. (2006). Municipal solid waste management challenges in developing countries – Kenyan case study. *Waste Management, 26*, 92–100.

Herrera, M. (1992). Environmentalism and political participation : toward a new system of social beliefs and values ? *Journal of Applied Social Psychology, 22*(8), 657-676.

Institute for Global Environmental Strategies. (2001). Urban Environmental Challenge in Asia: Current Situations and Management Strategies. Part 1: The Summary of UE 1st Phase Project. Urban Management Project. Japan: Institute for Global Environmental Strategies.

Jha, Abhas; Lamond, Jessica; Bloch, Robin; Bhattacharya, Namrata; Lopez, Ana; Papachristodoulou, Nikolaos; Bird, Alan; Proverbs, David; Davies, John; Barker, Robert. (2011). *Five Feet High and Rising Cities and Flooding in the 21st Century Policy Research Working Paper 5648.* Washington DC: The World Bank.

Lamond, J., Bhattacharya, N., & Bloch, R. (2012). The role of solid waste management as a response to urban flood risk in developing countries, a case study analysis. *WIT Transactions on Ecology and The Environment, 159*, 193-204.

Manaf, L. A., Samah, M. A., & Zukki, N. I. (2009). Municipal solid waste management in Malaysia: Practices and challenges. *Waste Management, 29*, 2902–2906.

McDougall, F., White, P., Franke, M., & Hindle, P. (2001). *Integrated Solid Waste Management: A Life Cycle Inventory.* London: Blackwell Science.

Miller, G. T. (1997). *Environmental Science: Working with the Earth* (6th ed.). California: Wadsworth Publishing Company.

Morka, F. (2007). A place to live: a case study of the Ijora-Badia community in Lagos, Nigeria. Case Study prepared for Global Report on Human Settlements. Retrieved December 25, 2014, from United Nations Human Settlements Programme (UN-HABITAT): http://www.unhabitat.org/grhs/2007

Morrissey, A., & Browne, J. (2004). Waste management models and their application to sustainable waste management. *Waste Management, 24*(3), 297–308.

Muñoz-Cadena, C., Arenas-Huertero, F., & Ramón-Gallegos, E. (2009). Comparative analysis of the street generation of inorganic urban solid (IUSW) in two neighborhoods of Mexico City. *Waste Management, 29*(3), 1167-1175.

National Environmental Standards and Regulations Enforcement Agency (NESREA). (2014). Retrieved March 5, 2014, from National Environmental Standards and Regulations Enforcement Agency Web site: http://www.nesrea.org/faq.php

Nwufo, C. C. (2010). Legal Framework for the Regulation of Waste in Nigeria. *African Research Review, 4*(2).

Ogbodo, G. S. (2009). Environmental Protection in Nigeria: Two Decades After the Koko Incident. *Annual Survey of International & Comparative Law, 15*(1).

Ogwueleka, T. C. (2009). Municipal solid waste characteristics and management in Nigeria. *Iranian Journal of Environmental Health Science & Engineering, 6*(3), 173-180.

Olurominiyi, I. (2008, August 26). *Transboundary dumping of hazardous waste*. Retrieved March 6, 2015, from The Encyclopedia of Earth: http://www.eoearth.org/view/article/156687/

Onwughara, N. I., Nnorom, I., & Kanno, O. (2010). Issues of roadside disposal habit of municipal solid waste, environmental impacts and implementation of sound management practices in developing country "Nigeria. *nternational Journal of Environmental Science and Development, 1*(5), 409–417.

Oyeniyi, B. A. (2011). Waste Management in Contemporary Nigeria: The Abuja Example. *International Journal of Politics and Good Governance, 2*(2.2).

Parrot, L., Sotamenou, J., & Dia, B. K. (2009). Municipal solid waste management in Africa: Strategies and livelihoods in Yaoundé, Cameroon. *Waste Management, 29*, 986-995.

Petts, J. (2000). Municipal waste management: inequities and the role of deliberation. *Risk Analysis, 20*(6), 821–832.

Petts, J., & Edulijee, G. (1994). *Environmental Impact Assessment for Waste Treatment.* Chichester: John Wiley and Sons.

Smit, W., & Parnell, S. (2012). Urban sustainability and human health: an African perspective. *Current Opinion in Environmental Sustainability, 4*, 443–450.

Suocheng, D., Tong, K., & Yuping, Y. (2001). Municipal solid waste management in China: using commercial management to solve a growing problem. *Utilities Policy, 10*, 7–11.

Swan, A. (2010). How increased urbanisation has induced flooding problems in the UK:A lesson for African cities? *Physics and Chemistry of the Earth, 35*, 643–647.

United Nations. (1992). *United Nations Conference on Environment & Development Rio de Janerio, Brazil, 3 to 14 June 1992 AGENDA 21.* Retrieved March 25, 2015, from United Nations : https://sustainabledevelopment.un.org/content/documents/Agenda21.pdf

United Nations. (2014). United Nations, Department of Economic and Social Affairs, Population Division World Urbanization Prospects: The 2014 Revision, Highlights (ST/ESA/SER.A/352). Retrieved March 25, 2015, from United Nations Web site: http://esa.un.org/unpd/wup/Highlights/WUP2014-Highlights.pdf

United Nations Human Settlements Programme (UN-HABITAT). (2010a). *State of the World's Cities 2010/2011: Bridging the Urban Divide.* London: Earthscan.

United Nations Human Settlements Programme (UN-HABITAT). (2010b). *The State of African Cities 2010: Governance Inequality and Urban Land Markets.* Nairobi: Earthscan.

Watson, D. (2013). *Municipal Waste Management in the United Kingdom.* Retrieved March 25, 2015, from European Environment Agency Web site: www.eea.europa.eu/...waste/united-kingdom-municipal-waste-management

World Bank. (2012). What A Waste : A Global Review of Solid Waste Management. World Bank.

Yunus, M., & Kadir, K. (2003). The development of solid waste treatment technology based on refuse derived fuel and biogasification integration. *International Symposium on Renewable Energy.* 14–17 September 2003 Kuala Lumpur