Sanitation Health Risk and Safety Planning in Urban Residential Neighbourhoods

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Abstract

The aim of this review paper was to determine the best sanitation health risk and safety planning approach for sustainable management of urban environment. This was achieved by reviewing the concept of sanitation safety planning as a tool. The review adopted exploratory research approach and used secondary data obtained from various sources to reach its conclusion. The findings reveal that, multiple approaches are required to reduce health risks associated with sanitation. It is concluded that sustainable sanitation safety planning is imperative in every developing nation's urban neighborhood. It is therefore recommended that sanitation standards should be set through consultative process; and monitoring should be participatory and multi-dimensional in approach.

Keywords: *Health Risk, Safety Planning, Sanitation, and Sustainable Development*

Introduction:

Global projections on *population growth* suggest that the world population of over 6 billion in 2000 will increase to 7.8 billion in the year 2025 (World Water Day, 2001). Similarly, it is estimated that about 300 million Africans; that is, half of the urban population in Africa will be living in slums in the year 2020 (Kariuki, 2003). Most of this growth will take place in slums and urban neighbourhoods where overcrowding, inadequate housing, water supply as well as sanitation services are prevalent (United Nations Millennium Development Goals Report, 2006). These statistics create a new face to the current sanitation crisis faced by significant proportion of the population living below the poverty line in overcrowded slums and sprawling peri-urban areas around major cities in developing countries. How to cope with the sanitation and its health risk as well as putting the delivery of sanitation infrastructure and hygiene services in urban areas to keep up with the pace of rapid urbanization growth that is essential for the protection and promotion of individuals' and community health that enables a productive and dignified life is necessary.

This led United Nations General Assembly on the July, 28th (2010) cited in Lancet, (2010) to adopted a non-binding resolution calling on states and international organizations "to scale up efforts to provide safe, clean, accessible and affordable drinking-water and sanitation for all", enshrined as basic human rights. Access to basic sanitation infrastructure that is proper for 'use and disposal of wastes' can substantially reduce pathogens and infectious waterborne diseases (WHO, 2008). Inadequate sanitation or lack of access to sanitation poses a great threat to human health, bringing heavy death toll on especially children and, endangering the environment (Aleksandra, 2007).

The challenges of sanitation in most of the developing countries' urban neighborhoods is that it is a common practice for people to defecate in any available open space or abandoned building structure due to absence of close-by toilets or, poor management of public ones. Similarly, the "flush and discharge" systems are expensive and most communities in developing countries cannot afford them making it not suitable in addressing the need of sanitary services (Aleksandra, 2007). These, contribute greatly to the problems, of groundwater pollution through seepage, as a result of pits and septic tanks often not emptied in good time and overflow, or the sewage are not treated or only partially treated before being discharged or thrown away resulting in poor sanitary condition and high probability of health risk (Luiza, *et al.,* 2015). Health risks associated with sanitation arises where the infrastructure provision and related services are poor, especially from lack of efficient management system along a chain line process (i.e. from capture/collection to final disposal/reuse) were pathogens and vectors spread by getting into contact with humankind. This becomes a risk and burden to communities or neighbourhoods in most urban centers of developing world.

In assessing the health risks associated with sanitation, various approaches have been used. However, rapid participatory sanitation system risk assessment (RPSSRA) technique is found

to have more robust framework and is less sophisticated and does not require the use of microbial analysis (Luiza *et al*, 2015). Health risk classification based on RPSSRA techniques are categorized into three major groups, these include: hazardous event indicators, exposure indicators, and vulnerability indicators (Luiza *et al,* 2015). The aim of this paper was to review sanitation health risk and safety planning approaches in urban residential neighbourhoods with a view to determining the best safety planning approach for sustainable environmental management.

The following constituted the objectives: (i) To review concept of sanitation safety planning as a tool; (ii) To highlight the importance of water and its implication on environmental health, (iii) To identify a framework of disease transmission routes in urban environment (iv) To appraise the techniques of sanitary risk assessment indicators; hazardous event, exposure and the vulnerability indicators (v) To evaluate safety planning approaches and (vi) To proffer environmental planning recommendations

Methodology for the Review

Based on the stated objectives of this review, the study was conducted using exploratory research method. This involved the use of information available from different secondary sources. This is guided by the philosophy and ontology specifically that deal with what we can learn and do with what is the nature of the world we experience (McNabb, 2009 & Ibrahim, 2015) to justify the existing problem within the context of experiences of sanitation safety planning in residential neighbourhoods.

Literature Review

Concept of Sanitation Safety Planning as a Tool

Sanitation safety planning (SSP) is a strategy or tool used for risk management of sanitation systems to guide the implementation of the WHO guidelines for safe use of waste water, excreta and grey water in agriculture and aquaculture (WHO, 2006). SSP provides practical step by step guidance to reduce the risk of contracting pathogens and microbial vectors that are associated with sanitation system chain. The underlying purpose of sanitation safety planning is to protect public health and that management and investment in improvement on sanitation system will be made based on adequate understanding of the actual health risks posed by the systems and how these risks might be best controlled (WHO, 2006).

To ensure sanitation safety planning is managed, a variety of users are targeted at different levels, these include: local authorities, waste water utility managers, sanitation enterprises and farmers and community based organizations (Reed, 2000). The objective is to systematically identify and manage health risk along the sanitation chain, guide investment based on actual risks, to promote health benefits and minimize adverse health impacts; and provide assurance to authorities and public on the safety of sanitation. A good sanitation safety plan must be developed in accordance with the WHO modules (WHO, 2006). These modules include: (i) Preparation for the sanitation safety planning, (ii) Description of the nature of the sanitation system, (iii) Identification of

hazardous events and assessment of existing control measures and exposure of risks, (iv) Development and implementation of an incremental improvement plan, (v) Monitoring of control measures on variety of performance indicators and (vi) Development of supporting programs and review plans.

Water and its Implication on Environmental Health

Water is an essential resource for life and good health. Lack of or access to good and adequate domestic water supplies can lead to the spread of diseases like diarrhoea, cholera, typhoid etc. (United Nation Development Programme UNDP, 2005). Diarrhoea, cholera, typhoid etc., are diseases attributed to poor water supply, sanitation and hygiene which account for 1.73 million deaths each year and contribute to over 54 million disability adjusted life (WHO, 2003). These diseases occur due to consumption of unsafe water, poor sanitation and hygiene. These diseases are believed to constitute 6th highest burden of diseases on a global scale, a health burden that is largely preventable (WHO, 2003). Other diseases related to poor water, sanitation and hygiene include: trachoma, schistosomiasis, bilharzia, guinea worms etc. Recent outbreaks such as that of cryptosporidiosis in Milwaukee (USA) and E.coli Campylobacter Jejune in Walkerton, Ontario, illustrate that the developed world is not spared of the risk either (Mackenzie, *et al.,* 1993; Connor, 2002).

In a study in Peru, Gilman *et al.* (1993) found a positive relationship between quantity of water available in the home and frequency of hand washing. Indeed Hurttly, Moris and Pisani (1997) reported a medium reduction of 35% in diarrhea disease morbidity through hand washing. Van der Hoek, Feenstar, Konradsen (2002) in a study in Pakistan demonstrated that increased quantities of water available at households were critical in preventing stunting. In Bangledesh, the country with most widely reported problem of Arsenic contamination, between 35 and 77 million people are at potential risk (Smith, Lingas, & Rahman 2000).

Pruss and Mariotti, (2000) reviewed 19 studies on water quantity and trachoma and noted that there is a significant relationship between water quantity and trachoma incidence. They noted that in one study in southern Morocco households using less than 5 litres of water per day had more cases of trachoma than households using more than 10 litres of water per day.

Uwejamomore (2011) lamented that waterborne diseases like diarrhoea, cholera, typhoid etc., cause scourge among children. He noted that 11 percent of all under-five deaths occur in Nigeria. Based on UNICEF records, children continue to suffer disproportionately from diarrhea disease with more than 2 million children under age 5 dying every year from diarrhea and pneumonia related illnesses. The simple act of washing hands with soap at critical moments such as after and before handling food remains a key cost effective and life-saving intervention (Akintola, 2011).

Raji and Ibrahim (2011) in their study in Sokoto, Shuni and Tambuwal towns in Nigeria, reported high incidences of water-

borne infections such as typhoid, cholera, dysentery, diarrhea and gastro enteritis to water scarcity. They reported that water borne infections in the three towns increased from 10.03% in 2004 to 14.14% in 2005. Diarrhea which constituted 6.23% in 2004 and 10.04% in 2005 was the most commonly reported.

Denis (2005) reported that in Jos, Nigeria, there are more than 20 cases of cholera outbreak due to water scarcity. In Ebonyi, Nigeria, 50 people died from cholera in July 2015 (Eze, 2015). Uzoamaka (2010) found water supply in Enugu Urban to be grossly inadequate. According to her this perennial water scarcity has prompted the digging of wells on any available space within house premises, because of that quality standards were compromised, resulting in exposure of waterborne diseases such as typhoid, dysentery and infections hepatitis.

Table 1: Frequency of Waterborne Infection in Shuni, Sokoto and Tambuwal Towns in Nigeria

Infection	Shuni (n= 2000)	Sokoto (n =2700)	Tambuwal (n =3653)	Total Number of Cases (n = 8353)
Diarrhea	179 (8.95)	130 (4.81)	212 (5.80)	521 (6.23)
Dysentery	11 (0.55)	98 (3.63)	97 (2.66)	206 (2.47)
Gastroenteritis	4 (0.20)	41 (1.52)	0 (0.00)	45 (0.54)
Typhoid fever	5 (0.29)	2 (0.10)	0 (0.00)	2 (0.04)
Schistosomiasis	11 (0.55)	35 (1.30)	20 (0.55)	66 (0.79)
Total	205 (10.25)	304 (11.26)	329 (9.01)	838 (10.03)

Source: Raji & Ibrahim (2011)

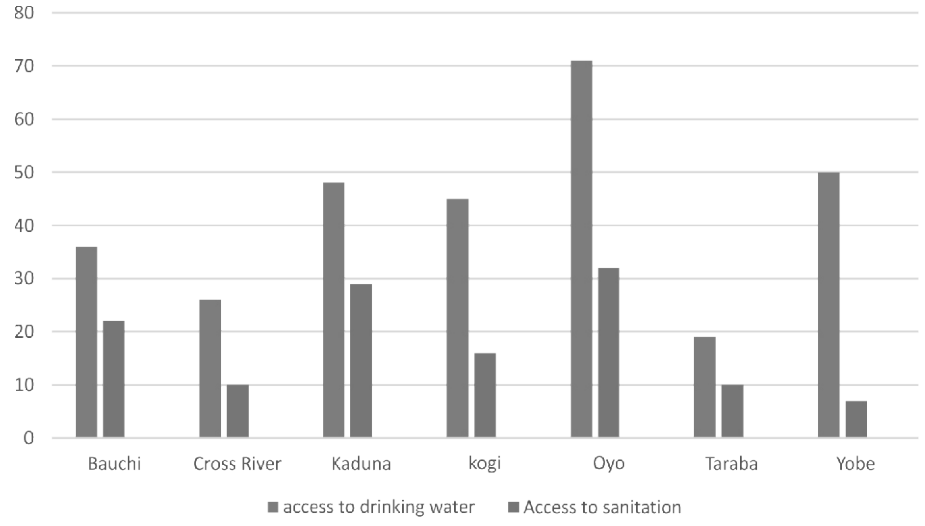

Fig. 1: Access to Water and Sanitation in Selected Nigerian States.
Source: WHO, 2010

Theoretical Framework of Disease Transmission Route in Urban Environment

Eisenberg, Scott and Porco (2007) reported that environment and social conditions affecting health are linked and any process affecting human health is the combination of the two. So understanding the determinants of sanitation risks relating to both sets of factors are necessary to develop strategies that prioritize sanitation intervention for communities that are at most risk.

Cairncross, Blumenthal, Kolsky, Moraes and Tayeh (1996) made distinction between transition routes of infectious diseases within domestic household domain to public domain (e.g. streets, workplaces, schools etc.). This concept is used to define four domains in the urban environment, each of which is identified by the predominant disease transmission pathway.

These relate to contamination of the household and public domain (indirect transmission), as well as direct transmission via contamination of water supplies or the food cycle. In each domain, there are specific conditions and practices or behavior that increase disease transmission, as well as other environmental factors not directly related to excreta management that increase health risks.

Wagner and Lanoix (1958) and Carr (2001) highlight the pathway of disease transmission related to fluids, flies and fields. Although in their assertion, polluted water is perceived to be the mechanism for the transmission of microbial pathogens, the direct person-to-person pathway generally predominates especially where faecal contamination of the domestic environment is high (Curtis, 2000). However, different interventions reduce disease transmission by interrupting the different pathways. Understanding of the relationship helps the design and implementation of the management scheme so that, they lead to a decreased risk of disease.

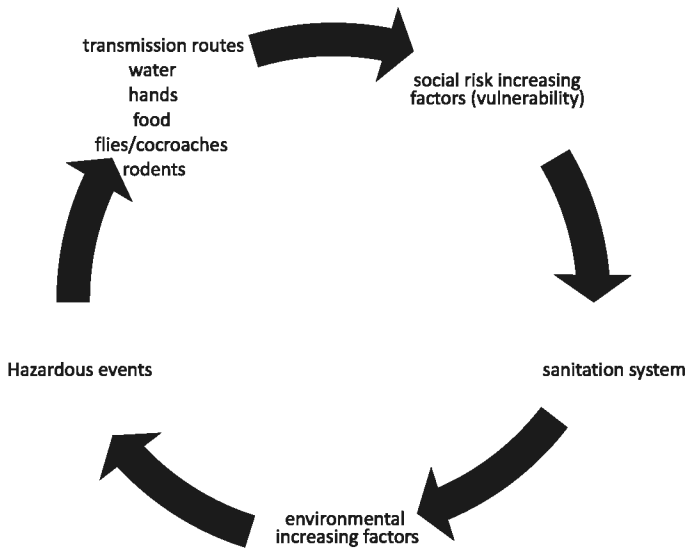

Fig 2. Disease Transmission Routes Related to Sanitation Framework

Techniques for Sanitation Risk Assessment

There are various techniques that are used to assess health risk related to sanitation. However, all the techniques are based on assumption that sanitary products are not safely contained; and that residents are at risk of exposure to faecal matters containing pathogens that may lead to illness and further propagation of disease (Luize *et al.,* 2015). The techniques are different but have the same goal to assess condition in the urban environment for health risk of the communities:

(I) Quantitative Microbial Risk Assessment Technique (QMRA): this is a technique that combines counting of indicator pathogens with dose-response relationships in order to estimate risks to human population at critical point for disease transmission within a network which are commonly referred to as "hotspots". But its wide spread is limited by:

- ➡ The need for accurate and representative data on local disease prevalence, pathogens exposure and appropriate dose-response relationship (Medema & Ashbolt,2006)
- ➡ Results from QMRA can also be a basis on which to standardize exposure-dose relationship for other less intensive methodology (WHO, 2005).

(ii) Sanitation planning technique: this is a technique that is more recently developed by WHO to assess health risks related to use of residual liquid waste stream from sanitation systems (WHO, 2015). This technique focuses primarily on the disease transmission routes within the domain of two bottom quadrants (contamination of the water cycle and contamination of the food cycle).

(iii) SaniPath technique: This is a technique that is used to assess health risk associated with household sanitation and community facilities and associated hygiene behaviors. The technique quantifies the risk exposure to faecal contamination in the public and private domains using a combination of data obtained by QMRA, rapid assessment tool to assess the level of contamination, and participatory stakeholder's consultation to assess the frequency of exposure (Moe, 2014).

(iv) Environmental health risk assessment (EHRA): This is a technique that is more qualitative, developed and applied for mapping sanitary condition to support city sanitation planning for rapid environmental health risk assessment. In the use of this technique, priority areas are identified according to:

- ➡ Context (poverty levels, population density, size of population and urban/rural characteristics). And
- ➡ Exposure which takes into account behavioral issues (e.g. hand washing), water supply, waste water and solid waste service and drainages. The techniques is simple but nevertheless is relatively easily understood by all stakeholders. A mapped sanitation risk index (SRI) is the final result of an EHRA study, and for each city, the results are documented in a book with the aim of ensuring that funds for upgrade are allocated to priority areas

(v) Rapid participatory sanitation system risk assessment (RPSSRA) technique: This is a technique that was developed to support sanitation planning in a situation where information about existing system is scarce. This is aimed to act as an interface among government agencies, private sector actors and poor communities that currently lack adequate sanitation services. The technique was designed to address

various urban sanitation challenges at scale in Sub-Saharan Africa by developing solutions focusing on the entire sanitation delivery chain.

Indicators for Health Risk

The indicators are categorized into three major groups with each having its own variables for assessment. These are: hazardous events, exposure and vulnerability.

Hazardous Events: This is determined primarily by coverage and quality of sanitation systems. The lower the coverage and the quality of the sanitation system, the higher will be the frequency and the extent of the hazardous event. Also there are other factors that are recognized to increase the probability or the severity of hazardous events in terms of their intensity or duration. For example, the performance of drainage and solid waste systems is widely recognized to have direct implication for the performance of excreta management systems and therefore, in many municipalities drainage and solid waste systems are considered to be part of sanitation (Luize *et al.,* 2015).

The indicator variables for hazardous events include:

(I) Toilet coverage: If people do not have access to latrine they are forced to practice unsafe sanitation. This situation can cause people to be exposed to faecal matter (Rheingans, Anderson, & Showalter, 2012).

(ii) Condition of latrine facilities: Poor quality or dirty latrines mean faecal matter is not contained. Latrines that are dirty are likely to be focal points for disease transmission and are associated with insect vector (flies/cockroaches).

(iii) Desludging: In urban areas, when latrines are full, there is often no space to dig another hole and full latrines must be emptied. If desludging services are poor and waste is not taken away from the local area, then it is often dumped in the local environment, consequently, people are exposed to faecal matter (Eisenberg *et al.,* 2007).

(iv) Solid waste collection: Solid waste clogs drains. Nappies (diapers) containing faeces and plastic bags containing faeces may be disposed of indiscriminately with rubbish or at refuse collection points (Cairncross *et al,* 1996).

(v) Domestic waste water disposal: Drainage systems are frequently contaminated by wastewater discharge (either directly from the toilets or indirectly from septic tank overflows or disposal of faecal sludge) (Wagner & Lanoix, 1958).

(vi) Flood/storm water drainage: Flooding of sanitation systems results in increased transmission of faecal-oral diseases. Poor natural drainage also creates ponding and damp conditions, which are conducive to micro-organism survival (Carr, 2001).

Exposure Indicators: These are determined by two major variables; proximity to the hazard and transmission pathways. It depends on the type and intensity of contacts between the hazard and individuals in the community. The intensity of exposure depends on the pathogen concentration within the waste, the type of contact and the duration of exposure (Yang *et al.,* 2012). Another important factor is over sharing of latrine, increases the potential for transmission of pathogens (Heijnen *et al,* 2014). The variable that describes the major

two categories are:

(I) Proximity to hazard:

➡ Settlement density- overcrowding leads to overuse of latrines, problems of access for installation and servicing of facilities, and conditions that are conducive to spread of communicable/infectious diseases (Curtis, Cairncross & Yonli, 2000).

➡ Sharing of latrines- shared/overcrowded latrines elevate health risks as a result of increased contact with other people and dirty toilets (Stenstrom, Seidu, Ekane, & Zurbrugg, 2011).

(ii) Transmission pathways:

➡ Hygiene behavior: Hands are widely recognized to be the critical point in the transmission pathway of faecal-oral disease (Medema & Ashbolt, 2006).

➡ Water supply: Water from intermittent piped systems or from shallow/unprotected wells is prone to contamination; poor water supply also makes hygiene-related washing more difficult (WHO, 2003).

➡ Waste water use: Wastewater or faecal sludge may be applied to market gardens or farmers' fields to support food production but if untreated there is an increased risk of disease transmission (Moe, 2014).

(iii) Vulnerability: This relates to an individual's susceptibility to contracting disease, the effects that the disease has upon the individual's health and the consequent impact that it has upon their livelihood.

The selected indicators are closely related to a complex range of socio-economic factors that define poverty. This is widely recognized to have widespread implications for human health where water and sanitation provisions are poor (Philip & Rayhan, 2004). The chosen indicators as factors of increasing social risk are:

➡ Housing condition: Housing and built environments are acknowledged to have a profound impact on human health (Moe, 2014), but at the same time reflect a wider set of poverty-related factors that may increase vulnerability.

➡ Number of children per family: Children, particularly under-fives, are more vulnerable to diseases (Utomo & Listyasari, 2010).

➡ Education: A low level of education may be an underlying risk factor for diarrhea disease (Crichton, 1999) in particular, where hygiene practices is the major source of risk (Medema & Ashbolt, 2006).

Sanitation Safety Planning Approaches

Various urban sanitation safety planning approaches have been developed in an attempt to untangle the complexities of sanitation matters (Scott,Cotton & Sohail, 2015). However, it is a chain of sanitation services and is collectively known as faecal sludge management (FSM) planning. This is described as the predominant sanitation system planning in the developing world (International Water Association, IWA, 2006).

The general concept frameworks developed are described as domain-based approach and sanitation system approach. Both predicted on an understanding of the demand for sanitation, but one focuses on the decision makers at different levels, the other on the physical

systems that decision are made about respectively.

Domain-based Approach

This approach is designed to tackle urban sanitation from the perspective of its institutional context aimed to provide decision support for more appropriate sanitation. The concept, divided the urban context into series of concentric rings or decision making domains (IWA, 2006). Despite its analytical principle, the uptake of this approach in municipal sanitation planning system has not been widespread. Sanitation remains political priority where there are limited resources, lack of ownership and limited planning capabilities at both central and local government levels which hamper sustained planning efforts. This limitation of planning culture can make sanitation planning frameworks abstract and redundant in practice (Tayler, Parkinson, & Colins 2003).

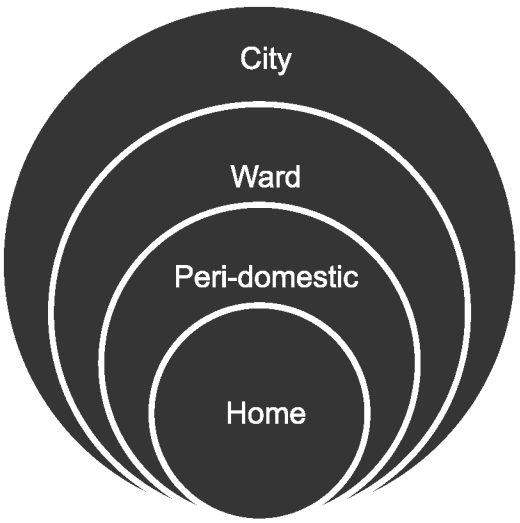

Fig 3. Sanitation 21 Model: Simple Approach to Complex Sanitation System
Source: IWA (2006)

Sanitation System Approach

This system approach is also called value chain. It systematically breaks down the sanitation into its component parts: capture; emptying; storage; transportation; treatment and reuse. This approach has in recent years become widely used as it identifies the component processes that are prevalent in urban neighborhoods. Furthermore, it has been instrumental in highlighting the critical downstream elements of FSM and also fits the ecological sanitation perspective as greater attention is paid to excreta reuse. It has proved a practical mechanism to map how the multiple actors of urban sanitation interrelate (Collingnon & Ve'zina 2000). The approach goes a long way to explain how urban sanitation works, insofar as they address the spectrum of institutional and financial issues and offer a good way of visualizing and analyzing problems. However, it has a limitation as it cannot explain why urban sanitation systems work the way they do. Also the existing frameworks have not furthered our understanding of the drivers of household spending on sanitation. Therefore, their contribution to decision making is limited to the extent that it can guide targeted sanitation interventions that are inclusive of the entire urban population.

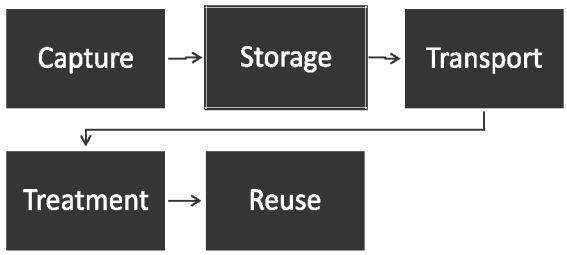

Fig 4. Sanitation and Hygiene Value Chain
Source: Bill & Melinda (2010).

The Way Forward for Sustainable Development

Dealing successfully with urban sanitation requires multiple approaches (Patel, Sheela, & Team 2015). This suggests that, sanitary risk can be minimized if monitoring is itself participatory, setting standards through consultative process and recognizing that urban neighbourhoods have to decide what works for them and how improvement can be achieved.

This indicate that safety planning is a critical factor if hygiene for all, end to defecation, improving water supply and sanitation management are to be achieved. Private and public costs of different sanitation system approaches have to be taken into consideration through answering chain of questions like:

- What do data on sanitation tell us about the neighbourhood?
- What standard is set for sanitation in our neighbourhood?
- From where and for what is finance needed for the sanitation?
- What is the political commitment of the neighbourhood on sanitation?

Conclusion

Understanding sanitation health risk and its safety planning for sustainable development in a developing nation is imperative. This is so because, globally, Africa suffers the most serious health risk and disease burdens. The prevailing conditions of these diseases are linked to inadequate sanitation and hygiene service which have killed more than 2 million people, more than diseases like HIV/AIDS in recent years. This is dangerous to every facet of development to a nation.

This paper reviewed sanitation health risk assessment and safety planning in urban neighbourhoods for sustainable development. Theoretical and conceptual frameworks of disease transmission routes in urban environment were also reviewed. The paper identified the techniques of sanitation risks assessment and risks indicators. Various safety planning approaches in the literature were also reviewed.

Recommendation

In view of the review, the study recommends the following:

I. Sanitation should be multi-dimensional in techniques and approaches to be successfully achieved.
II. It should be self-participatory by the individual community members in monitoring the process.
III. Standards for the sanitation process should be set through consultative processes by the individual and community at large.
IV. Communities should be strengthened through individual participation in improving water and household hygiene and sanitation management process.
V. Stakeholders should have the political will or commitment in providing infrastructure and the services needed for actualizing sanitation processes.

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