Chapter 2

Waste Management Threats to Human Health and Urban Aquatic Habitats – A Case Study of Addis Ababa, Ethiopia

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Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/48077

1. Introduction

Over recent decades one of the commonest characteristics manifest in the developing nations has been the disparity between rapid urban population growth and sanitation infrastructure provision. This disparity is being worsened by the challenges of poor waste management practices impacting on the deteriorating ecosystems of the rapidly transforming cities in these countries. The product of this mismatch, described as 'urbanisation without health', is the catalogue of overcrowding, growth in illegal settlements, uncollected household waste, and the absence of water, sanitation and other basic facilities which are typical of many urban centres in Africa, Asia and South America. As a result many millions of the urban poor live in neighbourhoods typically hazardous to their everyday health and general well-being. The major concern is that despite advances in technology and innovative responses towards mitigating the threats to environmental health, notable deficiencies in the access, maintenance and management of sanitary facilities in the cities of most developing countries still persist. Despite these advances, the question is why are the environmental threats endangering human health and ecosystem welfare on the increase?

In explaining this question, some studies have argued that the rapid rates of urbanization in Third World countries – in both spatial and demographic terms, are urban growth and transformations in Third World countries in recent decades – which are the major drivers of the current environmental and public health problems [1, 2]. An environmental health problem has been defined as "either an inadequate supply of a resource essential to human health or urban production (e.g. sufficient fresh water) or the presence of pathogens and toxic substances in the human environment which can damage human health or physical resources such as forests, fisheries or agricultural land" [3]. Most studies, discussed in this

chapter, concur that the health of the residents of Addis Ababa is imperiled by the pitiable physical environmental conditions that are presently characterized by poor shelter, overcrowding in squalid housing and neighbourhoods, unsafe drinking water, poor sanitation, water pollution, indoor and air pollution and poor waste management. This poor urban environmental fabric, worsened by the low priority accorded to sanitation, has been largely blamed for the high incidence of waterborne pathogens in the catchment interface of Addis Ababa that are responsible for the spread of communicable diseases such as cholera, typhoid, and amoebic infections, mainly dysentery.

The built-up area of Addis Ababa – featuring ultra-modern buildings adjacent to slums - lies within the Big Akaki and Little Akaki river basin which has a catchment area of about 540 square kilometres. The Big and Little Akaki rivers, with their dendritic tributaries, drain the city from north to south (Fig. 1). The inappropriate practices of dumping household and industrial wastes in the river catchments has resulted in the spread of anthropogenic diseases in the city. Some earlier studies lament that the biological pathogenic vectors in the hydrological cycles of urban centres in Ethiopia account for four-fifths of all diseases and the related high mortality rates [4]. These diseases have been closely associated with the high prevalence of urban poverty and weaknesses in municipal waste management interventions – thereby increasing the vulnerability of the majority low income households.

Recent studies have established that nearly two-thirds of the urban citizens of Ethiopia use pit latrines for sanitation while close to a third defecate in open fields and less than 5% of the population use flush toilets [5]. It is mainly the residents in the slum settlements, constituting an estimated 80% of Addis Ababa's estimated 4 million people, who live with the most insidious environmental problems due to poorly developed existing environmental infrastructure and services such as sewers, drains, or services to collect solid and liquid wastes and safely dispose of them [6]. This situation is comparable to other sub-Saharan African cities where the majority of the urban population – 65% in Dar es Salaam [7], 67% in Blantyre [8], and 80% in Luanda [9] lives in squatter settlements. The most recent household survey conducted in 1998, revealed that 11% of the households in Addis Ababa had private flush toilets, while 73% owned private or shared pit latrines and 16% of the households had no toilet facilities of any kind [10]. In the peripheral residential areas of the rapidly sprawling city, 40% or more of the households had no access to latrines. It is common practice that some of the city residents who have no access to both public and private latrines are forced to defecate in nearby open grounds hidden from public view or else they have to walk longer distances to ravines, ditches, or wooded areas. The sight of some residents resorting to relieve themselves in public along road pavements and in storm water drains is also common – not least, in the congested areas of the city such as Merkato, Piassa, Bole and Gurd Shola.

Not surprisingly, the informal vending and sub-letting of private latrines on house plots and in the concealed spaces is a growing trend in the poorly serviced slum areas of Addis Ababa. The bathing of limbs on street pavements and in the congested public spaces of the city centre is a common sight during the lunch hour breaks. The practice is most visible

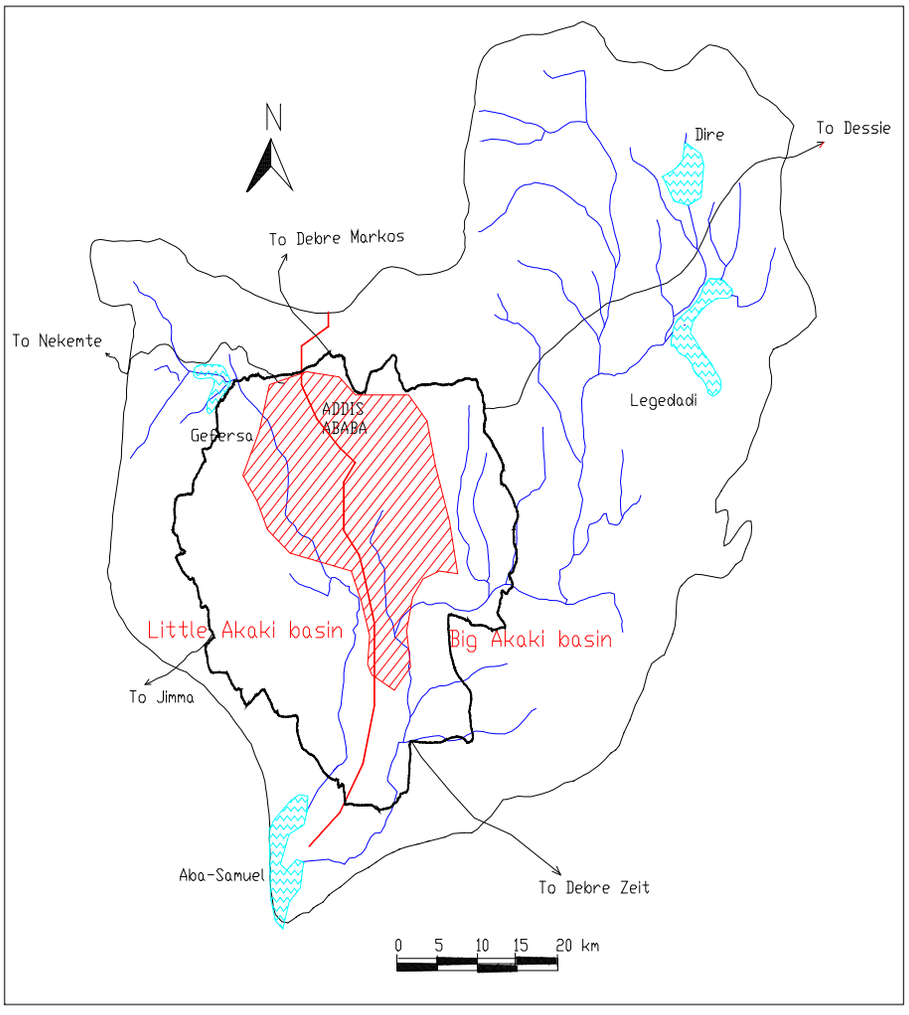

Figure 1. Addis Ababa catchments of the Little and Big Akaki River basin.

along the pedestrian alleys of the Merkato Open Air Market and the congested bus termini throughout the city. Urinating and defecating on open spaces scarcely hidden from public view - does not seem taboo (Fig. 2 a and b). These examples illustrate the rising importance of the environmental health risks inherent in the waste management challenges at the municipal, neighbourhood and household or personal levels. In addressing such challenges, both international and development aid communities have recognized the identification of waste management as an integral component in the conceptualization and implementation of city-wide development policy strategies – guided by the protection and enhancement of ecosystem services. Thus the United Nations Conference on the Environment and Development concluded that "…solid waste production should be minimized, reuse and recycling maximized, environmentally sound waste disposal and treatment promoted and waste service coverage extended" [11]. Not surprisingly, the UNCHS Habitat prioritizes "environmentally sound and resource efficient approaches in mitigating the problem of growing solid waste quantities, and considers waste management as a crucial component of human development policies and programmes" [12, 13].

(a) (b)

Figure 2. a. Waste dumping site in Merkato; b. Human excreta in home surroundings in Merkato

The management of waste in the urban centres of Ethiopia is the responsibility of the Municipal Division of Health. All municipalities – except the chartered cities of Addis Ababa and Dire Dawa who have cabinet representation – exercise some autonomy in managing their own affairs. All the chartered cities and the certified smaller urban centres are mandated "to provide, maintain and supervise environmental health services along with other activities in their own areas" [14]. However worthy these objectives sound, most of the municipalities and urban centres do not seem to have efficiently run environmental planning and management institutions let alone sufficient resources for discharging their responsibilities effectively. This scenario is worsened, in part, by the sustained low priority accorded to essential sanitation activities in most of the country's urban centres largely attributing to insufficient local revenue bases. Besides their routine administrative duties, the sanitarians assigned to the regional health departments and environmental health centres can only afford attending to emergency cases especially water pipe outbursts and toilet flooding - considered imminent threat to the residents.

With this scenario in view, the chapter assesses some of the current waste management practices of domestic households in the slum areas of the city and the risks to both human health and ecosystems that these practices play out in the surroundings of homes and aquatic systems of Addis Ababa. In doing this, the chapter draws on the growing body of literature on waste management in urban Ethiopia in order to trace some of the important relationships between the current waste management practices and their impact on public health, especially in the congested parts of the central business district (CBD) of Addis Ababa. In the context of this chapter, solid waste management is taken to mean "the

processes of controlling the generation, storage, collection, transfer and transportation, processing and disposal of solid wastes in accordance with the best principles of public health, economics, engineering…that is also responsive to public attitudes" [15]. Meanwhile, sanitation will be taken to extend further than physical access to latrines and toilet facilities such as hand washing basins, cleaning towels and lighting. Sanitation encompasses the whole process of enhancing the conditions of the living environment (both inside and outside the home), personal hygiene, as well as improving the physical infrastructure of [latrine and] toilet facilities, a safe and adequate water supply, and the safe disposal of domestic solid and liquid wastes [16][own emphasis]. The quality of water – for domestic or personal consumption - dependents on healthy ecosystems and sustainable land use management in watersheds.

The chapter examines some of the key underlying questions of improving the sustainability of ecosystems and the environmental health status of sub-Saharan African cities that continue to be threatened by the fragmented waste management policy responses using an ecohydrological perspective. As a new trend of thinking towards promoting livable urban settings, the theory and implementation of ecohydrology has been developed in the framework of the International Hydrological Programme of UNESCO (Zalewski *et al.*1997[17]; Zalewski and McCain 1998[18]). Zalewski *et al.* (2010: 102) have suggested that "an integrative approach, expressed by ecohydrology principles, should be helpful to distillate the general patterns of ecohydrological interplays, which confronted with social challenges [largely due to the rapid urban population growth rates and underlying transformations] should provide a dynamic framework for the formulation and implementation of realistic strategies for problem solving by focusing on ecological processes for enhancing sustainability [19][own emphasis]. But why is the ecohydrological perspective particularly useful for mitigating the negative effects of the current poor waste management on the environmental public health status of residents through the enhancement of ecosystem services to society? In answering this question, Zalewski *et al.* contend that "…given the conditions of the increasing demographic pressures, sustainability can be achieved through policy responses that regulate the whole range of water biota interactions with the human settlement activities towards enhancing the carrying capacity of the city – water resources, biodiversity and ecosystem services [20]. Due to the complexity of such interactions, an integrative understanding of the interactions between different biological and settlement activity patterns in urban ecosystems is essential. The integration for synergy in the basin scale and regulatory measures have been viewed as reducing the negative effects of the cumulative load of excessive effluents into the acquatic system significantly [21].

The essence of the ecohydrological perspective is rooted in the defining classification by Odum (cited in Zalewski et al 2010:102) that "ecology is the economy of nature" [22]. Thus the implementation of this strategy posits that the enhancement of the carrying capacity of urban ecosystems has to begin by quantifying the hydrological cycle (such as trends in the eutrophication of rivers through waste dumping) and the identification of threats to ecosystems and public health engendered by such waste disposal practices. The next step is

the assessment of the ecosystems as they are modified by human settlement activities, their distribution in the catchment interface and their impact on the livability of the urban built environment. Finally, the regulation of water biota processes through interventions such as the reduction of point source pollution should be based on an understanding of the hierarchical complexity of ecological processes in the catchment area [23]. However, this approach contradicts the many environmental management policies that are top-down (command and control approaches) involving direct regulation along with monitoring and enforcement standards, permits and licences that have been criticized for being costly and difficult to enforce [24, 25]. The regulatory approaches have been perceived as contributing to the worsening of environmental health risks attributing to waste management policy strategies, mainly due in part to the lack of awareness of existing environmental instruments on the part of many residents [26, 27].

In this definitive context, the chapter examines the current domestic solid and liquid waste management practices in Addis Ababa with a view to suggesting possible policy options for mitigating the environmental health risks that are highlighted in the most recent literature (Kebbede 2004 [28]; Kuma 2004 [29]; Tadesse *et al.* 2004 [30]; Bihon 2008 [31]; Van Rooijen *et al.* 2009 [32]. A number of environmental health problems occurring at the varying spatial scales from the home through the neighbourhood to the city will be reviewed in light of the findings of case studies carried out mainly in the built-up area of Addis Ababa. The surveys by Abebe 2001[33], Kuma 2004 [34], and Tessema 2010 [35] attribute the proliferation of pathogens in the living areas of poor homes and neighbourhoods to a combination of inadequacies in the provision of sanitation facilities, inappropriate anthropogenic practices of sanitation at household level and the current waste management problems. The surveys reveal that the cramped living conditions and the presence of pathogens in the home environments due to the lack of basic infrastructure; the dangerous and unhealthy sites of some neighbourhoods due to the irregular or non-collection of garbage and the city-wide problems of toxic or hazardous waste disposal pose the major threats to the health of most residents in city.

The upsurge in the urbanization and industrialization following the structural reform programmes adopted by most sub-Saharan African countries is generating domestic waste in the form of raw sewage, untreated effluents with potential contaminant pollutants and toxic waste in the urban settlements. Current literature reveals that most of this waste ultimately finds its way into the clogged city streams and rivers ending up in inland water bodies such as the Aba-Samuel Dam, one of the main sources of water supply to Addis Ababa city. This trend persists as the standard practice by both the population and the practitioners. According to Alebachew *et al.* (2004), deficiencies of sanitary services, low capacity for urban waste management and the absence of regulations and scientific criteria for enforcement pose increasing environmental and public health hazards in the major towns of Ethiopia [36]. Arguably, there are many interconnected factors militating against the current top-down policy engagements in mitigating these problems. These factors include massive rural-urban migration fuelling rapid urban population growth, poor planning and ineffective development control measures, weak urban institutions, and

insufficient institutional resources set aside for tackling the ever present environmental health risks prevailing in the city. Drawing on the diverse case study findings reviewed in this chapter, the empirical findings of our case study suggest that the integration and harmonization of the interactions of hydrological and ecological processes in urban settings, and striking the balance, can be the key for sustainable waste management in the "city-to-come" in sub-Saharan Africa - comparable to Addis Ababa.

Ligdi and Nigussie (2007) suggest that the presence of elements of ecohydrology in relevant policy and project documents, as well as the various capacity building efforts are good starting points to promote the use of ecohydrology in the country [37]. This approach will have the potential of bringing the fragmented approaches into one whole system that promotes sustainable waste management. Specific studies that can reveal the importance of the hydrological and ecological processes in managing waste should be carried out in selected "ecological hot spots" [38]. The results of such studies will help in convincing decision makers and practitioners to understand the value addition of ecohydrolgy as a tool for integrated waste management in the fragile ecological hot spots prone to widespread anthropogenic health risks. We first turn to the problematic of environmental waste management in Addis Ababa to help us map out the spread of pathogens and threats to the health of residents living in the overcrowded enclaves of the city particularly in Merkato and Kasanchis where the epidemiological footprint and its associated anthropogenic practices is most visible.

2. Research problem

The challenges brought about by inappropriate anthropogenic practices threatening the health of most residents and sustainability of the existing aquatic habitats are mostly visible along stream banks and public open spaces in Addis Ababa ranking the city as one of the dirtiest in the world. These threats and related land use imbalances have not scaled down for a long time in the city [39] owing mainly to unrelenting in migration into the city and the paucity of resources to manage the increasing quantities of waste accumulating in the living spaces. The excessive pressure of "unplanned" (by modernist planning standards) land uses including encroachments on the fragile aquatic systems through the dumping of all range of solid waste into the riverine network seems to continue unabated (Fig. 3 a and b). The impacts of poor waste management and disposal most visible in the slums of the city have associated with the endemic spread of communicable diseases affecting mainly the poor sections of the city residents.

Table 1 depicts the trends in the spread of the top ten diseases mainly attributed to the indiscriminate solid waste management practices in the city. As can be noted in the table, the number of cases and their frequencies over the three years was too high for a city of 3 million (in 1999) relative to other cities in developing countries.

However, even these figures obscure the true picture of the number of cases not reported to the health institutions and the widespread practices of self-treatment and traditional healers in the city.

(a) (b)

Figure 3. a. Car washing contaminating groundwater; a. Quarrying and structures encroaching stream bank

Solid Waste Related Diseases		1997	1998	1999
1.	Parasitic infection	57 887	36 827.	36 845
2.	Bronchitis	38 100	28 849	28 780
3.	Skin diseases	34 426	27 119	27 047
4.	Broncho pneumonia	30 219	25 744	25 158
5.	Dysentery	20 782	13 596	14 631
6.	Bronchial asthma and allergic conditions	11 607	7 677	6 291
7.	All other respiratory diseases	7 932	3 845	7 532
8.	Typhoid	6 596	3 622	4 046
9.	Influenza	3 593	1 905	1 858
10.	Trachoma	1 619	1 015	1 346

Table 1. Solid waste related diseases and morbidity in Addis Ababa (Source: Annual Morbidity Report of Addis Ababa 1997 – 1999). *Please note that the data for 1997 include clinics whereas data for 1998 and 1999 cover hospitals and health centres only.*

The studies by Girma Kebbede (2004) and Kuma *et al.*(2005) suggest positive relationships between the worsening environmental health status of Addis Ababa and the current uncoordinated waste management and refuse disposal practices playing out at all levels in the ten administrative sub-cities of the capital [40, 41]. These levels include the domestic (on single house plot) point of source, neighbourhood (*kebele* or smallest administrative and political unit in Ethiopia) and municipal level. An overview of the stages of waste management in the separation, reuse and recycling of wastes reflect the current modernist approach to the waste management in the city. The first level of source separation is at household level involving street boys, private sector enterprises and waste pickers at municipal landfills. Plastic materials including glass and bottles are considered as valuable and usually sorted out for reuse. Recyclable materials include metal, wood, tyres, electricity products and old shoes. The role of the municipality in recycling is absent as the

municipality focuses on the collection, storage, transportation and disposal of waste. Most of the collection of recyclable wastes in the city is done by the informal sector. The recyclable waste materials are used by the local plastic, shoe, and metal factories. The municipality dominates the transportation and disposal of solid waste from garbage containers (secondary collection) to the dumping sites. The role of the private sector in the transportation of solid waste mainly involves the informal sector dominated by the deployment of door-to-door push-cart collection service. The push-carts dump the collected domestic waste, wrapped in sacks, at central collection points from where it is collected and transferred by municipal and private trucks for disposal at the only municipal dumping site known as Reppi or Koshe – 15 kilometres from the city centre. The present method of disposal is crude open dumping, notably, hauling the wastes by truck, spreading and levelling or compacting by bulldozer.

The current uncoordinated approach to waste collection and disposal has been mainly blamed for the high incidence of waterborne pathogens responsible for communicable diseases such as cholera, typhoid, amoebic infections and dysentery that account for four-fifths of all diseases in the country [42]. Kebbede (2004) attributes these endemic diseases to the deteriorating urban environmental conditions of all the country's urban centres. These conditions continue to manifest themselves in the increasingly poor housing shelter, overcrowding in squalid housing neighbourhoods, unsafe drinking water, poor sanitation, water pollution, indoor and air pollution and poor waste management [43]. It has been noted that despite the relatively long history of environmental health practices in the country since the early 1950s, the provision of services in the field still remains below expectations [44]. Kuma and Ali (2005) contend that the progress that has been made in environmental health service coverage so far does not seem to reflect any significant changes since the early 1970s. This is reflected by the current coverage levels of safe drinking water and latrines countrywide of 30% and 13%, respectively [45]. The per capita drinking water meets only half of the minimum requirement of 20 litres per person daily [46]. Arguably, most of the residents living in the slum areas or houses not connected to piped water have to obtain water for domestic use from vendors at high prices well above the tap price. In a study of household access to safe water in Addis Ababa, the UN-Habitat Report (2003) revealed that most (88.5%) of its residents had access to improved water mainly from piped water either into the dwelling or into the yard (67.8%)[47]. The study noted that, however, there are disparities between the ten sub-cities comprising the city. Bole sub-city, where the highest population of high income households lives, has the largest population (98.9%) with access to improved water while Akaki Kaliti and Nefas Silk depend on unprotected wells and springs for their water supply thus exposing them to anthropogenic health risks [48].

Equally, the access to latrines has similar drawbacks. These drawbacks include the limited achievements in environmental health service coverage over recent decades mainly owing to socio-economic factors and poor waste management practices detached from policies. How have these drawbacks given rise to the proliferation of environmental risks endangering the health welfare of most residents in Addis Ababa? The city has

inadequate, hygienically deplorable sanitation facilities in a terrain of rivers that have literally turned into open sewers over the years. Kebbede (2004) established that most public and private shared latrines in the city are unventilated, overused, unlined, collapsing and overflowing [49]. The unlit pit latrine superstructures are old and the wooden planks covering latrine pits are unstable and frequently fouled. On average, 34 people share a pit latrine. Over 70% of the latrines are shared by twenty or more users. The densely populated central areas have the highest percentage of households (50% – 60 %) using shared latrine pits. Many of the *kebeles* in these areas have 70% - 75% of their population using these latrines. One of the most poorly serviced, densely populated areas in the city is Addis Merkato. Over 60% of the residents of the Addis Merkato area use shared latrines and 25% have no toilet facilities. The shared latrines, sandwiched in between houses in collapsing superstructures, are overused and overflowing with raw sewage. Cleaning tankers cannot access them. Due to the lack of toilet facilities, roads often overflow with human excreta and garbage. The communal latrines provided are often blocked with all types of garbage and overflow into the streets attracting harmful insects and rodent vectors such as rats.

In the densely populated *kebeles*, the lack of space often forces large numbers of households to share the same latrine. Not surprisingly, residents of the *kebele* slum compounds make do with the inadequate and poorly accessible sanitation facilities and services. The tenants' lack of ownership of such dwellings provides little or no incentive to keep them clean, make improvements in the existing facilities, or build new ones. This also leads to the misuse of the shared latrine facilities, unhygienic and unsanitary conditions.

Private pit latrines are better constructed and maintained than shared ones. Most are ventilated (though some low-income households do not have ventilated pit latrines) and are made of zinc sheets, *chika*, or other scrap materials. Most private pit latrines have fewer than ten users. The proportion of privately owned houses is greater in the outskirts of the city and, thus, private latrines constitute 20% – 25 % of the sanitation used [50]. By contrast, less than 10 % of the sanitation consists of private pit latrines. The central areas are congested and house ownership issues are more likely to restrict construction of private latrines. The use of private pit latrines covers about 15% of the housing areas between the periphery and the centre of the city.

About 11% of the households of greater financial means in the city or more affluent suburbs have private or shared flush toilets. However, since most of these toilets are not connected to the main sewer network, septic tanks, cesspools and open waterways are used instead for discharging sludge [51]. Most of the sludge is washed into the nearby streams during the rainy season or percolates into the underground water table - the main source of borehole water for domestic use in most parts of the city.

There are more than 72 public toilets scattered in the city. However, most of these public toilets are located in central business district and a few are located in the peripheral commercial areas. They are extensively used and only men have access to them as they have no separate sections for women. All are maintained by the municipality and are designed as

squatting plates with flush systems. Most of them are dreadfully grubby. Only one of these toilets is connected to a reticulated sewer system. Thirty-eight of them have septic tanks that are connected to storm water drains and streams; the rest have no septic outlet and are emptied about twice weekly by tankers. These toilets are estimated to have 1 800 users/toilet/day. Many of the cisterns are broken and flush continuously. Many are not easy and safe to use, especially for children, the elderly, and disabled people as they are poorly lit. The maintenance and cleaning of public toilets are so poor that many people avoid using them.

In the context of the deteriorating environmental health status of Addis Ababa amplified by recent studies, the case study [52] sought to investigate the question why most urban residents in Addis Ababa live their everyday at the increasing health risks in their living areas. The findings of the case study suggest that an integrated approach to city-wide waste management and refuse disposal interventions incorporating the ecohydrological perspective can serve as a useful point of departure.

3. Aim

The chapter seeks to inform the current waste management policy interventions towards ameliorating the existing environmental health risks in Addis Ababa using an ecohydrological perspective. The major thrust of this approach is problem solving. Such a perspective can help in the understanding of the underlying interactions between local authorities, investors and local residents involved in waste management at the varying socio-economic and spatial scales – the home, neighbourhood through to city level – within a given ecohydrological system.

4. Objectives and research questions

The chapter evaluates the ecohydrological status and sanitation practices of living with environmental health risks in Addis Ababa by drawing on the findings of a recent case study by Mazhindu *et al.* [53]. The chapter provides an in-depth analysis of the case study findings answering the following key questions:

What are the trends in the spread of water-borne diseases to the urban residents of Ethiopia since 1998 to date?

How are the urban centres managing domestic wastes in the existing environment of both inadequate and poorly managed sanitation services?

What are the existing sanitation facilities and services at domestic and neighbourhood level?

What are the current domestic waste management and refuse disposal practices in the low income neighbourhoods?

How do the members of low income neighbourhoods perceive the waste management practices and performance of the city authorities?

What policy options remain open for sustainable liquid and solid waste management in the city?

5. Description of the study area

With the current estimated 4 million people residing in a built-up area of 290 square kilometres covering ten sub-cities (Fig. 4.). Addis Ababa shares an estimated 30% of the country's urban population signifying a population density of 10 345 persons per square kilometre. The city has arguably one of the highest populations in the world living in dilapidated and poorly serviced slum settlements largely located in the inner-city. Many slum settlements - including extensive very poor informal settlements dominate the flood prone areas in the oldest and overcrowded central parts of the city [54] including Merkato and Kasanchis. Squatters often select land not to be demanded for any other use in order to minimize the possibility of eviction. Such sites are likely to be dangerous and unhealthy. They include hillsides, flood plains, and polluted land sites near solid waste dumps or areas inundated with high levels of noise pollution. The flood prone areas along most of the river banks exhibit the most densely settled parts of the Addis Ababa, thus heightening the propensity of water stagnation and the spread of pathogens in the catchment interface. The population densities exerting pressure on the hydrology and the ecosystem services of the slum areas under study are revealed by the latest demographic transformations taking place in the city.

The most recent census figures published by the Central Statistics Authority of Ethiopia (2007) reveal a total of 52 063 households living in Addis Ketema sub-city covering an area of 85.95 square kilometres, where the most congested slum compounds of Merkato are housed. Addis Ketema sub-city has a population density of an estimated 4 284 households per square kilometer and the population of Merkato is an estimated 31 552 households. Kirkos (Cherkos) sub-city, housing the Kasanchis slum compounds, had a total of 54 398 households occupying a total area of 14.7

square kilometers. The total number of households in the slum compounds of Kasanchis is estimated to be 45 500 households. The least congested but better served slum areas of Meri-Luke feature in Yeka sub-city – home to 90 195 households living in an area of 85.94 square kilometres.

Some recent studies also observe that, elsewhere in the rapidly transforming sprawling landscape of the city, most residents live in poorly constructed sub-standard housing units (Fig. 5 a and b). These housing quarters are inadequately serviced in terms of the existing sanitation facilities due to the fragmented waste management approaches in practice [55]. Abebe (2001) noted that about 60% of the population of Addis Ababa lives below the poverty datum line [56]. According to UN-Habitat (2006) estimates, 80% of Addis Ababa's settlements are considered slum [57]. Khurana (2004) claims that the word "slum", originated from the word "slumber", which meant "a sleepy back alley" or "wet mire" or working class housing built near factories during the British industrial revolution [58]. The Collins English Dictionary (2007) defines a slum as a poor rundown and overpopulated section of a city [59] while the UN-Habitat Report (2003) depicts a slum as "a heavily populated urban area characterized by sub-standard housing and squalor" [60]. Slums happen and can also be perpetuated by a number of phenomena including rapid rural-to-

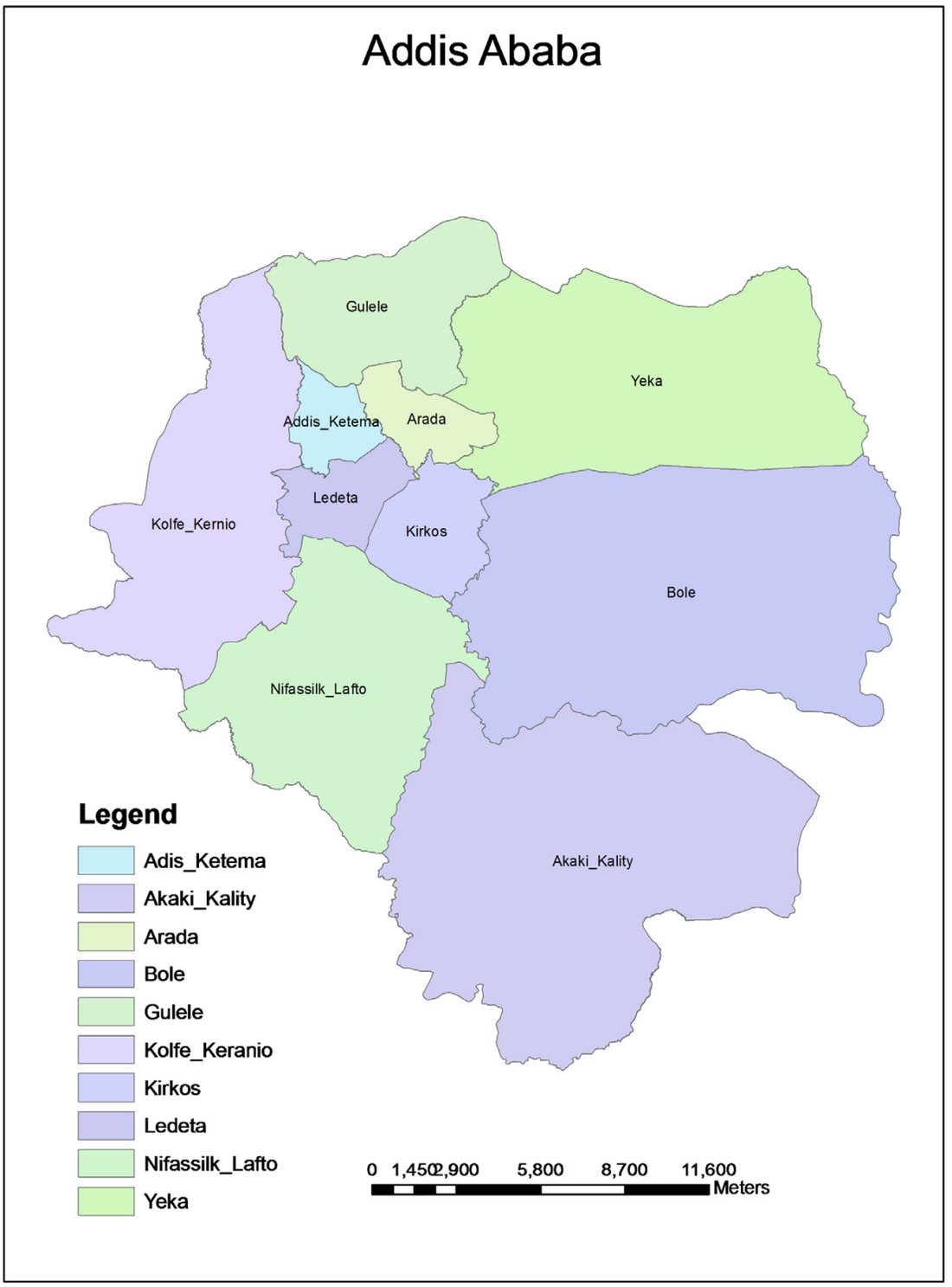

Figure 4. Administrative boundaries of Addis Ababa sub-cities

(a) (b)

Figure 5. a. Slum housing in Addis Ababa; b. Unplanned settlements on stream banks

urban migration, increasing urban poverty and inequality, insecure tenure on property, political conflict, wrong policies and globalization [61].

According to the population census of 1994, 4.4% of the houses in Addis Ababa had tap water inside whereas more than 45% obtained drinking water from vendors. However, the 2008 housing census in Addis Ababa registered a marked rise to an estimated 88.5% of the housing units with reticulated water supply albeit 28.6% of the households experienced frequent disruption thereby increasing the time and cost of acquiring water [62]. Moreover, the largely unregulated industries in the city and domestic households release harmful pollutants into the air, water and public open spaces, further endangering the health of residents as witnessed by the status of pathogenic infections in Lafto Sub-city in 2008 (Table 2).

Type of disease	Number of infected people	Percent (321 000 total population of sub-city)
Intestinal parasites	18 618	5.8
Common diarrhea	14 445	4.5
Respiratory infection	11 877	3.7
Amoeba	9 309	2.9
Typhoid fever	8 667	2.7
Typhus	8 346	2.6
Dysentery	8 346	2.6
Total	79 608	24.8

Table 2. Sanitation related diseases and infected people in Lafto Sub-city, Addis Ababa (Source: Nifas Silk Lafto Sub-City Health Centre Annual Report 2008)

Communicable diseases attributable to poor sanitation and practices, affecting mainly the underprivileged sections of the population, are considered as the major causes of morbidity, mortality as well as disability in Ethiopia [63, 64]. The high prevalence of communicable diseases in the country has been positively linked with the poorly developed socio-economic and environmental factors that have been inherent for centuries [65]. The rapidly shifting demographic and morphology of the city of Addis Ababa - featuring the rapid population size, widespread unemployment, the unremitting housing shortages, the demand for social and physical infrastructure are worsened by incompatible and unregulated land use activities. Such transformations are manifest by the proliferating squatter settlements in the interstitial spaces of the built environment, the dumping of solid and liquid wastes in open spaces, in the open sewerage drains and streams.

6. Applied methodology

Motivated by the growing body of literature on the environmental health risks to residents in Addis Ababa, Mazhindu *et al* [66] conducted a case study of the slum areas in Addis Ababa to assess the current domestic sanitation practices and impacts on the ecohydrological status of the rapidly expanding urban centres in Ethiopia. The case study reviewed the findings of earlier studies by Kebbede [67], Van Rooijen *et al.* [68] and Alamayehu [69] as a starting point.

Using an exploratory design, the study adopted a mixture of purposive and stratified cluster sampling techniques to diagnose the current institutional arrangements for waste management in the Addis Ababa metropolitan area and to identify the distribution, access, usage, quality and maintenance of existing sanitation facilities at local level. The study targeted the slum compounds of Merkato (in Addis Ketema Sub-city), Kasanchis (in Kirkos Sub-city) and Meri Luke in Yeka Sub-city, undoubtedly the most overcrowded experiencing the worst environmental health threats. In comparison to Merkato and Kasanchis, the study considered the slum areas of Meri Luke - in the eastern outskirts of the city – as a mixed density residential area for the largely mixed low and middle income households, as less environmentally threatened. Not surprisingly, however, the findings of the study established that all the slum areas visited exhibit very similar environmental health management threats to both human health and the degraded aquatic systems that increasingly dominate the undulating and thinly forested landscape of the rapidly sprawling city.

Merkato (Amharic for "New Market", popularly just “Mercato”, from the Italian for "market") is the local name for the largest open-air marketplace in Africa as well as the neighborhood in which it is located (Fig. 6a.). Merkato is located in Addis Ketema sub-city which is the smallest and most overcrowded of the 9 sub-cities of Addis Ababa. The sub-city has an average population density of 448 persons per hectare. Addis Ketema is viewed as the economic core of the country with transportation access to the rest of the city and the country. At Merkato main bus terminal (Fig. 6b.), about 950 buses serve commuters to all parts of Ethiopia everyday. An estimated 200 000 people visit Addis Ketema sub-city daily either on business or in search of employment [70].

(a) (b)

Figure 6. a. Merkato Open Air Market Stall; b. Addis Merkato Bus Terminus

The Merkato market covers several square kilometres and employs an estimated 13,000 people in 7100 business units. The open air market has over 120 stores and one massive shopping complex that houses 75 stores. The primary merchandise passing through Merkato comprises local agricultural produce — most notably coffee – cheap synthetic textile and electronic imports from countries in the Middle East and Far East.

The inquiry sought to collect both secondary and primary data on the trends depicting the spread of water-borne diseases in urban Ethiopia since the early 1990's. The study mainly sought to explore the major causes of deteriorating aquatic systems in relation to the worsening environmental health situation playing out in the poorly served and managed sections of the city. This required knowledge about the current waste management policy responsiveness of Addis Ababa concerning access, use, quality and maintenance of existing sanitation facilities and services at all levels. The study adopted the UN-Habitat (2003) definition of an adequate toilet facility as "an easily maintained toilet in each person's home or at a reasonable distance with provision for hand washing and safe removal and disposal of wastes" [71]. In this definitive context, the study assessed the adequacy of toilet facilities on the basis of ownership of toilets, the use patterns of toilet facilities by households, the types of toilets, the physical characteristics of toilets versus number of users, the filling of toilets and emptying periods.

Our exploratory research design deployed staff of three supervisors and four research interviewers, who graduated on the current Urban Management Masters Programme at the University of the Ethiopian Civil Service in Addis Ababa. The questionnaire was initially drafted in English, translated to Amharic, and then pretested in the similar slum housing contexts in the city adjusted to the features of suitability in terms of duration, language appropriateness, content validity, and question comprehensibility. Prior to commencement of the field visits, all study personnel were confident in interviewing skills, content of the semi-structured questionnaire, data quality, and ethical conduct of human research. Each research assistant surveyed an average of seven households per day in Merkato and

Kasanchis slum compounds as well as Meri Luke twice weekly for two months yielding a total sample of 160 people. Using both simple random and convenient sampling designs, a total of fifty households in each of the three study areas was interviewed to gather data on the frequencies, reflecting their opinions on the management of liquid waste at home, the efficiency of the refuse collection practices of the Addis Ababa municipality, the accessibility of sanitation facilities in the locality and the institutional capacity of the municipality for liquid waste management.

The case study initially reviewed the most recent studies (Kebbede 2004; Kuma 2004; Tadesse *et al.* 2004; Bihon 2008; Van Rooijen *et al.* 2009) on the provision of environmental health services in the urban centres of Ethiopia. These studies highlight the current trends of waste management and refuse disposal practices polluting the riverine systems of most urban centres in Ethiopia. To test the significance of the findings of these previous studies, we conducted personal field observation tours of the low income residential neighbourhoods in Addis Ababa. The pilot study helped in drawing the sample frame and units of analysis for the household survey. At the same time, we took pictorial samples of the existing sanitation facilities and domestic waste disposal practices in the study area. The pilot study sought to identify the most densely populated neighbourhoods of Addis Ababa exhibiting high incidences of ecological degradation, inadequate sanitation facilities and the impacts of the current solid and liquid waste management practices.

The study observed that the overwhelming majority (60%) of the houses in the current slums of Addis Ababa were built by feudal landlords of the Emperor Haile Selassie era, ending with the Marxist coup in 1974. The new regime nationalized all land and rental houses in decree number 47/1975. Rental houses were given to *kebeles*, urban dweller associations, for management. The current government, under Meles Zenawi since 1994, has not changed this policy and the state still owns all land, all rented units while the rents remain low and heavily subsidized. But having cut rent by as much as 70%, and passing all revenue to the central government, there is not much left for maintenance and construction. Residents have thus little incentive to move (even if they could afford to) and even less to improve the housing. The impossibility of access to land by the poor has ensured the proliferation of informal structures amid the formal – today a dominant feature of the sprawling cityscape and threat to environmental aesthetics.

7. Results

7.1. Management of liquid waste

UN-Habitat (2003:19) postulates that "a household is considered to have adequate access to sanitation if an excreta disposal system, either in the form of a private toilet or public toilet shared with a reasonable number of people, is available to household members" [72]. To determine the adequacy of access to sanitary facilities, the survey used a number of indicators, namely, the various types of toilet facilities available, the number of households sharing a toilet facility, the location of toilet facilities, structural quality of toilet facilities, maintenance and hygiene practices. Inadequate sanitation was taken to include service or

bucket latrines, and latrines with open pits. Similarly, UN-Habitat (2003) considers the sharing of a toilet facility with not more than two households as inadequate [73] augmenting the spread of pathogens through overcrowding.

As reflected in table 3, most 52 (63%) of the existing shared toilets were found in the *kebele* (smallest administrative unit in Ethiopia) slum compounds of Addis Merkato and Kasanchis followed by 28% on the rented housing properties.

Latrine ownership	Number of respondents by status of house ownership									
	Private		*Kebele* house		Rented House		Relatives		Total	
Private	35	*68%*	2	*3%*	8	*17%*	6	*12%*	51	*32%*
Shared	4	*5%*	52	*63%*	23	*28%*	3	*4%*	82	*51%*
Public	-	-	5	*71%*	2	*29%*	-	-	7	*4%*
No toilet	3	*15%*	17	*85%*	-	-	-	-	20	*13%*
Total	42		76		33		9		160	*100%*

Table 3. *Latrine ownership by status of house ownership* (Source: Field Survey, September 2009)

An earlier study by UN-Habitat (2003) revealed that the most of the households (61.4%) in the ten sub-cities of Addis Ababa share toilet facilities while most people (51%) share toilets with more than two households [74]. Mazhindu et al (2010) established that only 5% of the shared toilet facilities were privately owned whereas 32% of the privately used toilets comprised mainly the toilets on the privately owned housing properties in Meri Luke, Yeka Sub-city [75]. The majority (85%) of the respondents who had no toilets reside in the Merkato and Kasanchis *kebele* housing compounds. Both Merkato and Kasanchis slum areas are in the most densely populated and overcrowded sub-city of Addis Ketema where the UN-Habitat (2003) study earlier revealed that 85.6% of households shared toilet facilities [76]. Insofar as the number of households sharing a toilet can be considered a critical and defining level of sanitation adequacy, most (68%) of the respondents in Merkato and Kasanchis slum areas indicated that on average seven households share a latrine, albeit in some cases, more than seven households share one latrine. On the whole, most residents (51%) depend on share latrines, followed by 32% sharing private latrines, 4% sharing public latrines while a sizeable population of 13% has no toilet of any kind.

As an important aspect of access, the UN-Habitat (2003) postulates that sanitation facilities should be available without excessive demand in physical effort and time on the user [77]. Our study showed that access to the shared public latrines by households, particularly in the overcrowded Merkato and Kasanchis residential compounds, varied from household to household among other paraphernalia of access variables. The majority of the households in the Kasanchis slum compounds live considerable distances from the nearest shared toilet facilities. For such households, the walking distance to the nearest latrine or toilet facility may stretch from 500 metres to one kilometre – an unrealistic distance to access such facilities especially by the very young, elderly and disabled. Clearly, the location of shared pit latrines is not easily accessible to many members of households living in the congested

and marginalized areas without toilet facilities. The problem rests with the layout of facilities indifferent to the interacting linkages between several components in waste management and the conflicting interests among the different stakeholders in the use of space. This is a problem fix that has been scarcely touched in the urban development studies on Ethiopia concerning the spatial linkages between waste management service delivery and utilization in poor neighbourhoods.

Our physical assessments of the existing latrine facilities in all the slum neighbourhoods under study revealed that access was not the only constraint. In fact, most of the shared latrines were not readily usable. The physical characteristics of a latrine indicate its functional adequacy in satisfying the user needs such as hand washing receptacles and its environmental quality in terms of aesthetics and building fabric combine in determining the usability of the facility. The study established only 54% of the respondent households owned latrines complete with housing structures and door, while 27% owned toilets with the housing structure only (without door) and 19% owned open-air latrines.

The survey assessed the internal conditions of the latrine facilities and established that most (68%) of the existing latrines had cement floors whereas 32 % of the respondents indicated that their latrines had either wooden or mud floors. The study revealed that 8.6 % of the shared pit latrines were emptied twice annually but 11.8 % only once (Table 4).

Frequency of latrine emptying	Number of respondents	%
Once per year	18	11.8
Twice per year	13	8.6
More than a year	53	34.9
Never emptied	68	44.7
	152	100.0

Table 4. Frequencies of latrine emptying by annual interval (Source: Field Survey, September 2009).

Almost 45% of the respondent households indicated that they did not need to empty their traditional pit latrines since the pits would be covered with earth when full. Nearly thirty-five percent revealed that they channeled the sewage from the overfilling toilet pits into nearby open drains and waterways allowing it to flow along with domestic waste water ending up in the streams and tributaries that drain Addis Ababa city. Not surprisingly, the quantities of garbage and raw sewage accumulating in the catchments of Big and Little Akaki rivers, which flow into the Aba-Samuel dam, one of the main sources of water to Addis Ababa, have literally turned all the streams into open sewers threatening the city population with pathogens. This situation is made worse by the uncontrolled discharge of toxic liquid and solid industrial waste emitting from a wide range of large and small-scale factories that are clustered within the city that commonly rely on unregulated waste disposal systems [78].

Since efficient liquid waste disposal practices are equally essential for ensuring a safe and livable environment, the study established that there is no commitment on the part of

households in observing clean practices to safeguard or enhance the environmental health conditions of their living areas and surroundings. The study observed that most shared toilet facilities in the slum compounds of Merkato and Kasanchis were bereft of water taps and other hygienic ancillaries including hand-washing receptacles, disinfectants and anal cleaning materials. This situation is equally dire in the poorly served slum areas of Meri Luke where the unscheduled and frequent disruptions to water supply diminish the importance of personal hygiene practices to mitigate the increasing burden of communicable diseases and threats to the aquatic systems. Although disruption to water supply was not assessed as an indicator of access by the case study, an earlier study by UN-Habitat (2003:16) revealed that 28.6% of the households in Addis Ababa experienced terminal disruptions in the last two weeks. These disruptions affect mainly households that depend on public tap (34.1%), followed by water piped into yard or plot (31.6%) and water piped into the private dwelling (24.8%) [79].

7.2. Solid waste disposal practices

Our focus group discussions with *kebele* waste management officials reflected that most households were reluctant to pay for the municipality services rendered for solid waste removal. This coincided with the common practice of residents dumping all range of solid waste materials on the river banks, open sewers in the surroundings of their living areas (Fig. 7 a and b.).

(a) (b)

Figure 7. a. Garbage thrown into nearby stream; b. Scavenging and foraging on dump waste

Table 5 shows that 56% of the 160 respondent households deposited their solid waste in plastic bags while 19% dumped their solid wastes in open spaces, waterways and in the vicinity of their homes. Quite often, waste pickers team up with scavenging domestic animals including stray dogs and cats foraging for food on the dumping sites, tear the

plastic bags open causing offensive smells in the surroundings and exposing the unpalatable contents to people in the surroundings.

Primary collection method	**Frequency**	**Percent (%)**
Open container	25	16
Closed container	15	9
Plastic bags	90	56
Open space	30	19
Total	**160**	**100**
Disposal method		
Door to door	35	22
Homestead yard	30	19
Collection point	15	9
Waterways and open space	70	44
Burning	10	6
Total	**160**	**100**

Table 5. *Solid waste collection and disposal methods* **(**Source: Field Survey, September 2009)

While 22% of the respondent households had their refuse collected by the door to door municipal service in the more affluent Meri Luke area, 19% and 9% of the households in the slum compounds of Merkato and Kasanchis deposited their refuse either in the yards of their homesteads or at central collection points respectively. Disturbingly, 6% of the households burn their solid wastes causing significant air pollution. The study attributed the prevalence of improper solid waste disposal practices to the absence of household garbage bins thus reflecting some of the deficiencies of the municipality in regulating solid waste management.

7.3. Institutional setting for waste management

The study established that the management of waste in the city falls under the Sanitation, Beautification and Park Development Agency in collaboration with the Region 14 Health Bureau. The key players in the waste management sector in Addis Ababa are formal and informal operators in the processes of collection, separation, recycling, reuse and transportation of waste for final disposal at the city dumping site of Koshe. Formal operators are those registered and licensed to work subject to tax and space regulations. These operators include municipal cleaners and private operators authorized by government, whereas informal operators are not registered and have no legal base for the operation of their business. The latter category includes scavengers, unregistered recyclers and re-usable article sellers.

The general tendency in many African cities of associating work in the waste sector with certain ethnic, religious or social groups, has been questioned by Klundert *et al.*(1995:8) who argued that the sector serves as a niche for income generating opportunities and a viable source of livelihoods for the marginalized minorities in urban areas [80]. This argument was refuted by Chekole (2006) whose findings revealed

that the informal waste collectors in Addis Ababa constitute mainly the unemployed urban poor and individuals with other reliable income sources [81]. Chekole (2006) revealed the common practice of these informal waste collectors in organizing themselves into informal waste collection enterprises is based on social ties and living in the same neighbourhood.

On recognizing the advantages of participatory involvement in service delivery, the city government of Addis Ababa introduced regulations to promote the involvement of private institutions in the waste management sector. In its recognition of the vital role of the private sector in waste management, the Addis Ababa city government promulgated "Waste Management Collection and Disposal Regulations" No. 13/2004. The regulations stipulate that "service provided by government in the collection, transportation and disposing of solid waste may, through different participatory or transferring methods, be given to private sector investors" [82]. The city government justified this intervention on grounds that the involvement of the private sector – mainly medium and small scale enterprises – would ultimately pay off dividends by regulating citywide solid waste management practices. The city government viewed the pre-collection service offered by the existing informal waste collectors as fragmented and less effective towards achieving an ideally clean city. Moreover, the unregulated practices of informality in the solid waste sector were considered difficult to supervise regarding essential back-up services in the form of equipment and subsidies from government [83].

Our in-depth interviews with *kebele* (neighbourhood) representatives revealed that it is the responsibility of the *kebele* to keep its district clean. The *kebele* administration has the following obligations: to penalise dwellers caught throwing their waste around the containers; to visit the area and observe how dwellers manage to collect their waste; to conduct a campaign and clean the area, and contact the municipality to empty the bin frequently, and to construct latrines for those who do not have such facilities. However, *kebeles* are not able to penalize residents for throwing garbage in ditches and other open spaces, because this is usually done at night or when no one is around to evade prosecution.

7.3.1. Services expected from the Health Bureau

Our focus group discussions with *kebele* officials indicated that the *kebele* administrations responsible for Merkato and Kasanchis were often confronted with residents complaining about the garbage scattered around the containers, the bad smell and the health hazards that they pose in the neighbourhoods. The complainants suggested that solid waste collecting containers have to be emptied frequently albeit a *kebele* administration has no power to put pressure on the municipality to do so. The grieved residents also felt that the door-to-door collection service should comply with the dates and times for the convenience of all households. The *kebele* administration officials proposed regular consultative meetings with the Region 14 Health Bureau for concerted efforts in waste disposal and environmental awareness campaigns in all neighbourhoods.

7.3.2. Waste management malpractices in kebele neighbourhoods

Our focus group discussions with *kebele* officials responsible for waste management highlighted a number of malpractices in the collection and disposal wastes in the surroundings of homes adding to the eutrophication of the Akaki rivers. These practices are most visible both in the inner city of Addis Ababa including Merkato and Kasanchis as well as along the banks of Akaki River and its tributaries serving both as natural sewers and the mainstay of informal irrigation agriculture.

The *kebele* officials argued that since some distant *kebeles* do not have enough or convenient space to place garbage containers, residents are forced to walk long distances to neighbouring *kebeles* – to dump waste. Moreover, the existing garbage containers are not emptied frequently resulting in the accumulation of waste in open spaces. Alternatively, people throw their waste in sewers and ditches. Whenever the areas surrounding waste containers become muddy, people do not go close enough to the containers (skips), rather they just throw the garbage around the containers. The solid waste collection trucks only go where there is an access road. This means only those households that live along or near the road get the service.

8. Discussion

It is now generally agreed that prescriptive measures based on engineering and technological fix are unlikely to restore ecological processes of disturbed ecosystems [84]. The evidence of the degradation of natural ecosystems is overwhelming [85] in the rapidly growing cities of developing nations. Taking into account the concentration of nearly 70% of all industries in Addis Ababa, the uncontrolled discharge of industrial effluents into the Akaki River system is degrading the once pristine aquatic habitats. This has resulted in putting both human health and the absorptive capacity of the existing urban ecosystems under threat.

Ryszkowski (2000) has aptly observed that the integrity of biological and physical or chemical processes is a basic foundation of the modern ecosystem or landscape ecological approaches [86]. He has suggested that the recognition of the functional relationships between waste management practices and ecohydrological systems leads to the conclusion that biodiversity cannot be successfully protected only by isolation from hostile surroundings. Rather, its conservation should rely on the active management of the landscape structures through diversification.

The prevailing liquid and solid waste management practices in the overcrowded slum areas and the scattered industrial clusters in Addis Ababa pose considerable environmental health risks for the populace. This demands the awareness and active involvement of all stakeholders at all levels, whose interests and activities impact on the ecohydrological welfare of the city and its environs.

The daily waste generation in the catchment of Addis Ababa is reported to be 0.252 kg per capita per day and 65% (1482 cubic metres per day) of municipal waste is collected [87]. The

balance of 35% adds to the accumulating waste visible in the clogging or poisoning of riverine systems and the uncontrolled disposal of refuse on public open spaces (Fig. 8 a and b.).

(a) (b)

Figure 8. a. Refuse dumped on street pavement; b. Photograph 12: Industrial toxic waste water in a nearby stream

The uncollected solid waste has often the common cause of blocked drainages which exacerbates the risk of flooding and vector borne diseases thereby reducing the aesthetic value of green areas and the riverine systems that serve as the sewerage conduits within the densely built up slum areas of Addis Ababa. Climate change is augmenting the occurrence and spatial distribution of waterborne diseases such as malaria and rift valley fever. The incidence of cholera and other pathogens is on the increase due to poor sanitation, flooding of rivers and the extreme droughts [88].

There are increasing public health concerns about the excessive concentration of heavy metal ions (pH, Mn, Cr, Ni), coliform and pathogen pollution in the surface and groundwater of the Akaki River system [89]. Apart from supplying water to the city and serving as a natural sewage reserve, the easily accessible river water is the mainstay of the irrigated agricultural produce on which the city depends for its main fresh food supplies. Prabu (2009) investigated the toxic heavy metal contamination of Akaki River by measuring the concentration levels of seven selected metals Cd, Cr, Cu, Zn, Mn, Fe and Ni in associated with the current morbidity threats to human health and biosystems [90]. His results showed that the concentration levels of these metals in the river exceeded the regulatory limits set by the country's Environmental Protection Authority (EPA 2003). The laboratory tests carried out revealed varying proportions of the presence of all the selected heavy metals in the river – Cd (40%), Cr (64), Cu (15%), Zn (13%), Mn (4%), Fe (2%) and Ni (2%) [91]. However, the total concentration of Fe was two-fold higher than the limit set by the EPA, while Mn

concentration was seven fold higher than the limit. The presence of toxic heavy metal concentration in the Akaki River is due to the accumulation of both toxic liquid and solid waste generated by industrial, municipal and domestic activities in the neigbourhoods.

Arguably, as their only accessible source of livelihood, some households draw the polluted waste water from the Akaki River for washing and irrigating their market gardens. Fisseha (2004) observed that 40% of the vegetable supplied to consumers in Addis Ababa city and animal feed comes from the fields directly irrigated by waste water drawn from the polluted rivers during the heavy rainy season or in the dry season when the rivers manifest very low levels of water [92].

Our case study established that the inefficient solid waste management by the municipality has given rise to the accumulation of waste on open lands, in the open drainage system and in the vicinity of many households, causing a nuisance and foul-smelling pools, environmental pollution through leaches from piles (water and soil) and the burning of waste (air pollution), the clogging of drains, and the possible spread of anthropogenic diseases. Kuma (2004) testifies that unattended piles of waste provide a fertile breeding ground for disease carrying insects (mosquitoes, house flies) and rats [93]. The management of solid waste demands a sector-wide approach encompassing the cooperation and integration of government sector agencies, nongovernmental organizations, industry and the community based organizations in addressing the challenges. The importance of inclusive practices of good governance in prioritizing the efficient delivery of waste disposal and management services need to encourage an equitable provision and efficient use of sanitation facilities by all domestic users, industry and public institutions. A leading role in determining policies and projects should be given to local community representatives – especially of the disadvantaged domestic households.

9. Conclusions

Although Addis Ababa is endowed with abundant water resources, surface and ground water, the current health status and levels of safe water supply to sustain basic household hygiene and the public health of most residents, are unsatisfactory by world standards [94].

Arguably, the rapid population growth and expansion of Addis Ababa – mainly due to the in-migration of people coming from all corners of the country in search of better employment opportunities and urban services - pose the city with many challenges of waste management. Some studies have estimated that the rural population migrating to the primate city accounts for 40% of its annual growth [95]. However, coupled with its natural population growth, Addis Ababa happens to be one of the fastest growing cities in Africa. The combined pressures of urban poverty, widespread unemployment and affordable housing shortages are considered responsible for the continued loss of healthy aquatic reserves and the enduring environmental health to nearly 80% of the city' population of 4 million people, mainly housed in the slums and informal settlements. By and large, the emergence and episodic transformation of the city to its present mixed urban-rural zones attributes to the socialization of all land resources by the Derg regime

that denied any form of private land ownership. The absence of formal city planning to contain the imploding city population has led to the proliferating informal settlements that now dominate the built environment of today's Addis Ababa. The ecological footprint of informal settlements in the interstitial spaces of the city continues unabated as it eats into the once pristine biological reserves of available open space. The impact of all range of anthropogenic practices including the lack of proper sanitation and ill-disposal of liquid and solid waste on water resources and the health of residents embed themselves in the disturbances wrought by the failure of striking a balance between the consumption of ecosystem services (land, vegetation, water, biota, air) and conserving them in their natural state.

The chapter reviews the empirical findings of recent case studies on the impacts of the inadequacy of sanitation facilities, the related impacts of anthropogenic practices on public health and the degraded ecosystems of the rapidly transforming urban centres of Ethiopia on the basis of our exploratory case study on the slum areas of Addis Ababa. The majority (over 60%) residents in Addis Ababa live in slum settlements featuring poorly constructed houses, poor sanitary conditions, lack of all services (power, running water, and garbage collection), and lack of legal tenure on such residential dwellings. Public services and infrastructure such as running piped water and access roads visibly lack in most of these slum settlements – most of them comprise housing structures called *chekabit* (mixed mud and pole) are virtually overcrowded informal villages exhibiting pitiable living conditions. The inadequate provision and structural weaknesses in the management of sanitation and drainage facilities in the slums and informal settlements literally force residents to get by through resort to urinating and defecating in public open spaces, on river banks and in the interstitial spaces – usually - hidden from public view.

The city residents suffer from the prevalence of pathogens mainly because of the paucity of basic infrastructure and services such as sewers, drains, or services to collect solid and liquid wastes and safely dispose of them. Table 1 is indicative of the high incidences of water related diseases in Addis Ababa attributing to inadequate infrastructure and poor waste management practices steeped in the "throw-away" culture of the citizenry. The diseases include diarrhoea, dysentery, typhoid and intestinal parasites. These pathogens are a cause of many debilitating and endemic diseases that mainly afflict the urban poor households - hidden from public view in the backyard slums of the city. Invariably, the environmental health concerns of the home merge into or are part of the wider problems afflicting the neighbourhoods. The ecological footprint impacting on the riverine ecosystems illustrates the improper siting of the slum structures on dangerous precipices along stream banks. Not surprisingly, squatters often select land that is likely not to be demanded for any other use in order to minimize the possibility of eviction. Such sites are likely to be dangerous or unhealthy. They include hillsides, flood plains, and polluted land sites. The dendritic layout patterns of slum settlements in the city visibly lack in terms of passable access roads thus complicating the regular collection and transportation of domestic garbage. In the rainy season, the walkways turn muddy imposing the environmental health risks of the raw sewage flowing into nearby water bodies and inappropriately sited homesteads.

Our exploratory study confirmed that the deteriorating liquid and solid waste management situation in Addis Ababa imperils the health of the majority poor residents, most of them live in the most densely populated areas of the inner-city. Their uncontrolled domestic waste management practices in turn threaten the ecohydrological sustainability of the catchment basin of Little and Greater Akaki Rivers on which the city solely depends for its current and future growth. The findings of the case study established that there is a small sewerage network of the city, serving only 3% of the population. Most households (about 75%) use pit latrines discharging waste into open drains; about 15% have flush toilets and septic tanks; these likewise often discharging to open drains; a significant minority (about 5%) resorts to open defecation mainly along the stream banks. Such human practices have been construed to be the major culprits responsible for the contamination of water detrimental to the quality of soil and ground water resources through drainage and leaching. The concern about water quality is not out of place. What is needed, perhaps, is a paradigm shift by ecohydrologists that does not only recognize the intertwined ecological processes in urban catchments, but equally, the significance of mutually benefiting waste management practices in the planning and management of the diminishing ecohydrological reserves through predicting the influences of human activities on urban aquatic livelihoods.

The study validates the central argument in recent studies that the anthropogenic threats to groundwater and riverine systems are most prevalent in the overcrowded central areas of Addis Ababa due, in part, to the poorly serviced with basic sanitary facilities [96; 97]. In many cases, refuse collection is restricted to high income residential areas. There are no regular collections of solid wastes in the slum compounds. The uncollected refuse soon attracts rodents, flies and other vermin. The attendant threats have largely been blamed on the fragmented approach to sanitation and liquid management in Addis Ababa. This scenario has resulted in the accumulation of waste on open lands, in open drains, the living area of many people and the eutrophication of the city's traditional water sources and spread of water borne diseases (Tables 1 and 2). The study contends that the present system of solid and liquid waste management in Addis Ababa relies entirely on the municipality for the provision of the full range of waste collection and disposal services. This is proving to be a formidable task, and except for the privileged areas and institutions, the services offered have been recognized – at best - as largely inadequate. Even in the privileged or affluent areas of the city, refuse accumulates for weeks unattended. The current top-down approach arguably neglects the many constituent activities and actors of waste management in addressing the array of problems on a sector-wide basis.

Throughout this chapter, there have been frequent references to the need to direct multi-disciplinary energies in addressing the perennial challenges of waste management by examining the interactions between poor anthropogenic practices and the threats to both residents and the ecosystem services on which their livelihoods depend. Excessive preoccupation within individual disciplines, espoused in fragmented approaches to managing waste, lead to the neglect of the very challenges that desperately need attention as they unfold - in time and space. Clearly, the new approach will need new kinds of policy conceptualizations require the processes of collaboration and active involvement of all

stakeholders that must be developed and improved. At present, while waste management in municipalities is the sole responsibility of government agencies, if liberty of private action is to be retained, constructive collaboration can safeguard against excessive public control of development especially where the institutional capacity is limited. The roles and perceptions of both institutions and individuals in managing the accumulating waste quantities on open spaces and aquatic habitats of the city need to change in order to move out of the "waste management problem fix" towards adopting and implementing strategies that seek to protect and conserve the deteriorating urban biosphere reserves. These biosphere reserves include a variety of environmental, biological, economic and cultural situations ranging from largely undisturbed regions to cities [98].

Although the implementation of urban biosphere reserves (UBRs) is not widespread towards fulfilling sustainable development in practice, they are still spatially influential, open to innovative technologies and remedies for the outputs of the existing unsustainable urban living experiences [99]. There is a greater consensus on the importance of integration of bio-diversity with urban planning [100]. Apart from protecting biological diversity in and around urban areas, Azime Tezer (2005) advocates that the conservation of biodiversity will add more value to urban life through public public awareness of the economic benefits to be gained. Such an initiative primarily envisages a multi-disciplinary framework of watershed management comprising metropolitan administration, local governments, non-governmental organizations, research institutions and community representatives. An UBR can be part of a city, or surround a city, but not necessarily designated as a whole city. The reality urges greater attention to the reconciliation of development pressures with ecological units and biodiversity in urban areas.

Such strategies may need to consider the problem of multiple-deprivation, for, despite the existing range of social services and facilities, there appear large sections of urban residents whose relative standard of environmental health is deteriorating rapidly. An illustrative example, though not typical, is the inadequate father fails to meet the needs of a large family, who cannot a paying job and cannot afford any kind of descent home, who is unregistered by the municipality and ultimately degenerates into squatting on the precipice of a stream bank in the centre of the city. Hence the approach to many of society's problems need necessarily be synoptic in discipline, scale and agency. Our environment consists not only of density, and the accumulating waste in aquatic habitats but also of education, religion, social services, police and the planning process itself. Eversley (1978) rightly argued that "there is no such thing as an impersonal threat to the ecosystem: only our ignorant mishandling of the situation, and a lack of belief in the capacity of human dignity to cope with the new dangers" [101] constitutes the major threat.

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Acknowledgement

The authors are indebted to the Institute of the Polish Academy of Sciences, European Regional Centre for Ecohydrology under the auspices of UNESCO, the Department of Applied Ecology, University of Lodz, Poland, and the Division of Water Resources, Ethiopia – for organising the International Symposium "Ecohydrology for Water Ecosystems and Society in Ethiopia" in Addis Ababa - at which the findings on which this chapter is based were presented. We are grateful to Getawa Desta Tegegne and Semaegzer Aligaz Ligassu, both masters students at the Ethiopian Civil Service University, Addis Ababa, for producing the photographs that depict the current waste disposal practices and aquatic disturbances in Addis Ababa.

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