

Domestic Waste Management Strategies in Accra, Ghana and Other Urban Cities
in Tropical Developing Nations.

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Background:

The Republic of Ghana is home to 22 million residents. Accra, the nation's capital serves as the economic, administrative, and cultural center of the country. Its geographical position has allowed it to function as a natural port to the Atlantic Ocean, which has in turn made it an important destination point for number of Ghanaian trading industries. It covers an area of approximately 65 square miles.¹ It houses a full 18% of the total Ghanaian population and 30% of the country's urban population.² Unlike the towns and villages spread throughout the majority of the countryside, Accra is a veritable urban Mecca for labor-seeking residents from all over Ghana. Half of Accra lives below the World Bank's absolute poverty threshold of little less than a dollar a day³. Still, for the past two decades this city of roughly 4 million inhabitants has had an annual growth rate of 4% making it one of the fastest growing metropolis in Africa. This phenomenal growth has contributed to municipal waste production that far outstrips the city's capacity for containment and processing.

Ghana has waste management difficulties that extend from the state to the local municipalities, and refuse of all shapes and sizes is a common site in both urban and rural areas. These difficulties are concentrated and complicated by population pressures in the few heavily populated cities of which Accra is the most prominent. Inequality features heavily in the capital. 80 % of the city population lives in low income, high density population areas. The middle class is occupied by 17% of the population. Only 3% of Accra lives in high income, low density residential areas.⁴ The sanitary infrastructure of Accra is reflective of the income divisions. Only 30% of all houses have toilets that actually flush. Only 1 in every 5 houses has functioning indoor plumbing. The public latrines that have been built to accommodate these disparities are overused and often shared by 10 or more people.⁴

Visitors to Accra nowadays are confronted by two narratives. In one, Accra is the posh clean "gateway to Africa". Streets are manicured, palm trees are coiffed, and all the amenities of the western world including regular waste removal can be had. In the other version, city residents are contending with congestion, illegal settlements, substandard housing, and poor sanitation. This environment is the predominant experience of most city residents and is reflective of growing inequality that that has come to represent Accra. The confluence of poor governance and human factors (such as indiscriminate dumping) has resulted in a city environment characterized by choked drains, clogged gutters, and garbage piles heaped in the open.⁵

The story of how two such divergent experiences came to exist in the same city speaks to the challenges of urbanization with regard to waste management. Accra's modern day waste management deficiencies has its beginnings in the 1980s when Ghana was in a period of economic decline. A series of coups and political turmoil concurrent with a decline in the price of its largest exports (Cocoa) had caused a number of related industries to falter. The whole country was experiencing a decrease in productivity, living standards, and tax revenues. The contraction of the agricultural and mining bases spurred migration to the cities. The urban centers like Accra gained popularity as a potential places of employment for those migrants (mostly workers from the North) who had been dependent on the agricultural work provided by the Ghana's cocoa farms.

By 1985 the city's only incinerator had been nonfunctional for 15 years, and the pile-up of refuse particularly in the lower-income areas was an eyesore as population growth increased.⁶ With the assistance of the German government, a formal Waste Management Department was established as a branch of the Accra Metropolitan Authority (the local governing authorities) to handle the collection and disposal of solid and liquid waste in the metropolis. In 1999, to improve the range of coverage and consistency of service, a Canadian firm (City and Country Waste – CCW) was given a monopoly to provide waste collection and

disposal services in the capital. It only operated for a few years before the contract was abrogated as CCW was failing to achieve desired results. The cancellation of CCW's contract led to the present day waste management environment where 80% of waste-related services are provided by the private sector.

In Ghana privatization is usually an exercise meshing political capital with governmental responsibility. Many staff positions, jobs, and contracts are linked to the party in power. The management of public services can be disrupted cyclically with every election. New parties in power may remove those in charge of sanitation duties because of their support or installment by another party.⁷ Private firms are usually receiving the patronage of the current administration. The administrative priorities and the management approach of the Accra Metropolitan Authority [AMA] however have managed to remain rather consistent over the past decade, and by most accounts privatization has allowed AMA to increase the average yearly waste collected.⁸

Accra is currently divided into 16 waste collection zones each contracted to different waste management firm responsible for collecting and disposing solid waste. Collection of solid waste from these zones has been delegated to the private sector. The AMA concentrates on supervision of waste collection, monitoring of the public-private partnership, and management of final disposal points.⁹ The private local firms are the ones in charge of actual collection and provide their services for a fee according to specific contractual agreements that each company makes with the city authority, the AMA. The AMA pays those companies with national budgetary allocations from the state government and internally generated funds. Refuse collection is by either house-to-house or central container collection.

Approximately 20% of the population receives weekly house-to-house collection.¹⁰ These residents live in a cluster of high income low density neighborhoods nestled away from the coast. In such areas, curbside pickup is provided weekly, and residents are charged a fee for the service and an additional fee to lease the garbage containers. About 70% of this population actually pays these charges, but for the most part the service is well funded.

The other 80% of the population essentially receives this service for free. Most of this population lives in low-income areas. Central containers are placed at designated points for households to deposit their domestic waste. Trucks are supposed to collect the containers as needed, but service is variable because these collections are less lucrative and less reliable. A variety of pay-as-you dump initiatives (posting a person near each central collection container to collect fees as residents dump) have been attempted to provide more revenue for better service. However, these policies have failed to be sustainable as residents have simply avoided the central collection containers [CCC] in favor of illegal non-specified dumping sites like ditches and drains.¹¹ It is not uncommon for containers to become mini landfills as resident use the surrounding space for overflow refuse. Because these neighborhoods are overly crowded, squatters may settle without regard to city design. Thus many roads in poor neighborhoods cannot be traveled by sanitation trucks without exposing those trucks to potentially damaging road wear-and-tear. Consequently, some of these CCC are only emptied when laborers are hired to use handcarts to remove refuse from a CCC to a truck on the nearest safest road.

These two disparate collection schemes allow the AMA to collect approximately 55% of solid waste generated within the city.¹² Accra generates between 1500-1800 tons of waste per day, but it has the capacity to collect only 1200 (66%) tons per day. Poorly maintained equipment and inefficiencies in road design and urban settlement all lower the AMA collection capacity. At all the various levels of waste management, (sorting, collection, transportation, and disposal) there exist disruptions that pose a threat to the environment and public health. These inefficiencies in waste management are exacerbated by the AMA's indifference to the complaints of the public poor. Benneh et al point out that "half of Accra households perceive local accumulations of solid waste to be a problem, and more than one third mention open dumpsites in their neighborhood where waste goes uncollected for a week or more".¹³

The current situation is not tenable. The advent of e-waste imports—old TV sets, radios, and

computers from developed nations-- threaten to further destabilize an environmental approach that is not keeping pace with emerging health risks. In the near future Accra will have to improve its waste management. Oil has recently been discovered off shore.¹⁴ Drilling will begin in 2010. The indirect waste generated from the communities that will emerge to support this new industry will undoubtedly overwhelm the local waste management capacity.

This paper will center on the present approaches and strategies being used to address Accra's growing waste management problem. I will focus the analysis on solid domestic waste. Domestic waste is defined as the items originating from household activities such as cooking and human excreta that are no longer of use to the owners. Liquid waste, radioactive waste, and e-waste are important aspects of the overall waste burden. Municipal wastes—the trash from commercial establishments and small industries such as tins, plastic products, and polythene bags—also loom large as factors in Accra's waste problem. Nonetheless, they will not feature prominently in the analysis, as the main focus of this paper is to describe the domestic solid waste management landscape of Accra. Characteristics of Ghanaian society that both aid and detract from effective waste management will be considered. The environmental and health consequences of the waste dilemma will be explored. Solutions being proposed to help resolve the current predicament will be discussed.

Toxicology, Environment Health Risk Assessment, & Impact on Vulnerable Populations:

Domestic waste in Accra is primarily made of organic material (65%). The remainder of the disposed waste consists of paper, plastics, glass, metals and textiles.¹⁵ The organic material is typically a mixture of kitchen waste (vegetables, rotten fruits, crop residues, and leaves) and animal excreta.¹⁶ None of the organic material is in and of itself toxic to humans or the environment. Frequently it is the manner in which the waste is kept that dictates the exposure to health risks. The largest risk to humans comes in the form of diseases associated with unsanitary conditions. Infectious diseases of poor sanitation and poverty are the most common diseases affecting the residents of Accra. Vector born disease such as malaria, diarrhea, typhoid, bilharziasis, and hepatitis make significant health impact. More than half of these diseases are related to the poor sanitary conditions that exist and the attendant economic and social costs.¹⁷

In the Accra households it is not uncommon to find open waste containers. Many households store their waste in baskets and plastic bags. The hot and humid weather conditions favor accelerated corrosion of organic matter. If open containers are not emptied, the decomposing material will attract flies. The presence of flies in the household lowers the threshold for contamination of food and cooking items. These houseflies can act as vectors for various diseases by transmitting pathogens through direct contact or through their droppings. The high incidence of diarrhea in children under 6 is related in part to food contamination by flies.¹⁸ Hygiene related diarrhea alone is thought to cause 20,300 deaths per year,¹⁹ and is considered one of the most common presentations at outpatient Accra facilities.²⁰

Outside of the home, health risks are no better. When disposal facilities are not accessible or have overflowed, residents will dispose of their waste in open spaces and surface drains. If drainage channels becomes blocked with solid waste, water cannot drain from streets. Blocked drains and standing water pools are a contributing factor in the endemic status of Malaria. Malaria transmitting anopheles mosquitoes use the stagnant water piles as breeding grounds. Malaria accounted for 53 percent of all reported diseases at Ghana outpatient facilities in 1998, and is the leading cause of morbidity in Accra.¹⁷

The lack of substantive toilet infrastructure means that citizens at times resort to defecating outside. Past studies have found more than two-fold increase in childhood diarrhea prevalence due to neighborhood outdoor defecation.²¹ Insufficient communal facilities can lead to open defecation along beaches, drains, and open spaces. In this environment there is a tendency for fecal material to become intermixed with household

refuse. Street runoffs also become a potential source for human infection when drains become contaminated with fecal matter. Studies have found endemic fecal pathogens including parasitic worms, protozoans, bacteria, and viruses at concentrations great enough to create the potential for human infection.²² Even at non-infectious concentrations, some pathogens such as *Taenia saginata* and *Ascaris lumbricoides* survive at infective stages outside their host for months on contaminated grounds.²³ Therefore even if adults or children attempt to avoid fecal matter, they may be unknowingly working and playing on fecally contaminated grounds, increasing their risk of infection.

Poor sanitation practices are also a cause of cholera. Cholera, an acute intestinal infection caused by *Vibrio cholera*, infects humans through contaminated food and water. The standard treatment, oral rehydration therapy, is safe and usually effective. Nonetheless cholera symptoms (profuse watery diarrhea, vomiting) are unpleasant. It is considered a preventable disease in areas with adequate sanitation, but in Accra cholera outbreaks do occur—as recently as 2008—where persons perish needlessly.²⁴ Cholera persists in Accra because the *V. cholera* can survive outside in fecal specimens if kept moist. Thus the creation of open-space dumps less than 500 m away from community centers subjects residents to cholera infection risk.²⁵ This explains the statistically significant association between cholera prevalence and density of refuse dumps. Residents who live closer to refuse dumps are subject to more bouts of cholera.

Waste practices can cause air pollution. About 18% of households in greater Accra region (mostly low-income households) burn their waste.³ This burning can contribute to outdoor air pollution. Leachants from burned refuse can enter the groundwater. Leaching of refuse into water, particularly from household products like batteries, is a very pressing concern during the rainy season. Many neighborhoods are situated in low-lying areas which are susceptible to floods. Contamination of surface water in these flood prone areas raises the risk of exposure.

The burning of domestic waste has been associated with respiratory illness. Households that are serviced inconsistently by waste collection companies sometimes burn their waste. In these households, respiratory diseases are more common in mothers and children. One suspected cause of this association is that these households are prone to burn their waste, and burning is an activity primarily performed by women and children.²⁶ Women and children may be exposing themselves to harmful fumes and consequently presenting with a higher incidence of respiratory disease.

Water pollution is another important potential outcome of inappropriately managed waste. The unregulated leachants from refuse near waterways increase the technical difficulty of providing clean water and subject city residents to urban flooding risk. Urban floods occur when drainage systems and other storm control devices overflow because of waterway blockages.²⁷ Indiscriminate dumping and refuse overflow at CCCs can all be sources of drainage blockage. While it is true that seasonal rains can cause flooding in all parts of Accra, the poorer residences with their weaker drainage infrastructure are more likely to experience flood damage.

The poorer population of Accra bears a disproportionate amount of the environmental health risk burden. The most vulnerable populations are sanitation workers and the migrant workers from the North. Migrant workers frequently resort to scavenging to provide income. Scavengers can be seen in broad daylight searching through refuse at open dumps for materials—plastic slivers and metals—that can be sold back to processing factories.²⁸ These scavengers are exposing themselves to harmful leachants and chemicals without any protection.

Sanitation workers are hired by private companies. However, they receive little or no protective clothing from the waste management companies which employ them. These workers earn low wages, and thus are not able to purchase appropriate clothing for their protection. Thus, they suffer more exposure, and as a consequence have a higher turnover rate, higher incidences of sick days and work-related accidents, and higher mortality than the rest of the city population.⁴

Present approaches:

Many approaches to waste management exist. Generally, solid waste in Accra is managed through economic instruments, landfills, incineration, recycling or reuse. The antecedent condition for the effective application of all these tools is that which is central to many discussion concerning sub-Saharan progress—good governance. Broadly defined, good governance refers to the successful management of community affairs through the mixing of private, public, and voluntary actors.²⁹ Good governance encompasses visionary leadership. It incorporates legislated by laws. It enforces fines and punishments when those laws are disregarded. A thorough discussion of Accra's governance would necessitate a detailed retelling of Ghana's political history. For the purposes of this paper the reader should consider good governance as a potential moderator for each of the approaches discussed. Bad governance will weaken the approaches. Good governance will bolster the approaches. The relationship is reciprocal as well. Improvements to any of the elements discussed will in turn enable better governance.

Like most developing countries, Ghana and consequently Accra actually has an established set of comprehensive environmental laws. However it lacks the means to enforce those laws. We will consider Ghana's current legislative and administrative environment (corruption, political cronyism, etc) as fixed and discuss methods of improving waste management service delivery within these non-ideal environments. We will not discuss advanced waste disposal systems, such as gasification and pyrolysis,³⁰ which Ghana does not have the financial and technical resources to support. We will only address the technologies and approaches already in use in Accra and other comparable heavily populated urban cities in sub-Saharan Africa.

Economic Instruments: Privatization

The United Nations defines economic instruments as tools or actions which have the purpose of affecting the behavior of economic agents by changing their financial incentives.³¹ Economic instruments can be grouped into two categories: revenue-raising instruments (licenses, user charges), and non-revenue instruments (performance-based management contracting, clean neighborhood competitions, privatization). The problem of waste collection is structurally dissimilar from the problem of waste disposal.

The AMA's main economic tool is privatization. Advocates of privatization believe that for-profit competitive systems increase efficiency and better calibrate supply and demand. Opening the waste management market to competition can stimulate development of better pollution control technology and expertise. Before 1995 solid waste management was run purely as a government monopoly.³² However the government was failing to adequately address the sanitary needs of its citizens. Failures in public servicing opened the domain to various modes of public-private cooperation.

Surveys performed in both high and low income households indicate that post-privatization frequency of collection and cleanliness of service has improved.²⁸ Privatization has permitted waste collection services to be allocated to the parties who value them the most. Opponents to Accra's privatization program acknowledge that the living standard in higher social economic classes has increased, but they argue that the benefits of privatization are not experienced equally by residents of Accra. Poorer socioeconomic classes have only received marginal benefits.

Low-income residential areas (which make up the majority of Accra) are still under serviced.³³ Critiques of privatization point out that waste collection relies on the government management of infrastructure (ensuring streets are paved and accessible, enforcement of zoning laws against squatters) independent of public or private servicing. Private firms will only be as good as the infrastructure that supports them. Private firms have little incentive (and virtually zero technical capacity) to repair and maintain

roads. As a result many of Accra's initial experiences with decentralization of the waste collection market resulted in the neglect of lower income regions.

Privatization in its current incarnation has certainly improved the cityscape, but it has birthed an unfortunate set of circumstances that economic instruments are not suited to address – namely the problems of the commons. Privatization depends on fees. In high-income neighborhoods each household pays a fee for the privilege of waste collection. Houses are sufficiently spread that if a household determines not to pay the fee and waste accumulates, that action does not immediately offend the aesthetic environment of neighboring households. In low-income neighborhoods, the opposite is true. Waste is accumulated at central collection points. When payment schemes have been instituted (such as requiring residents to pay a specific fee before the central container units are collected), residents simply free-ride. Families have no incentive to pay for proper disposal. A household may pay for the right to dispose of waste in the central container unit, but may still be surrounded by filth if neighbors decide to unscrupulously empty their wastes in the streets. The population is too dense, and municipal workforce too sparse for effective policing of environmental by-laws. Thus paying households in poor neighborhoods receive little tangible aesthetic benefit as their immediate surroundings are still polluted by other residents.

Controlled Dumping

Controlled dumping refers to the use of landfills as terminal endpoints for refuse. It is the preferred method of disposal by the AMA, because it is the most affordable and requires the least maintenance. Cities are permitted to appoint designated landfill sites, but these sites are more accurately designated as open dumps. Sanitary or engineered terminal end sites for Accra's waste deposition are non-existent. Engineered landfills are constructed to meet specific environmental standards including low permeability clay liner and natural flow (gravity based) leachate management.³⁴ Ghana possesses only two engineered landfills in Tamale and Kumasi.³⁵ Accra's landfills mostly consist of abandoned stone quarry sites, gouged natural depressions in the earth, old mining areas, or man-made holes in the ground. Many of these sites are at the outskirts of the city where the poorly maintained roads present significant risks to waste transport.

The trouble with non-engineered landfills is that there is little capacity to protect the surrounding environment from the hazardous chemicals and leachants that will invariably be released in the dumped refuse. Leachants from these non-engineered dumps can flow into canals and drainage channels as runoff water and pose human health threats.³ The Ghanaian Environmental Protection Agency has recognized the need to have the municipal dumps of Accra replaced or upgraded to engineered landfills and has set a 2020 target for the conversion of all these sites.³¹ Presently, waste management disposal is underdeveloped. Most of these landfills operate near or beyond maximum capacity.¹³ Waste is not subject to compaction. Volume remains expanded, and as a result these dumps are frequently infested by roaches, rodents, and flies.

Composting:

Composting is the process of turning organic household waste into fertilizer through aerobic fermentation. This fertilizer can be used in lawns, parks, and gardens. Composting is a minimally used form of waste disposal in Accra and does not contribute to the danger of food pollution. Of the 1250 tons of garbage collected per day – about 10 – 15% is composted.³⁶ In theory composting could reduce environmental pollution and provide job opportunities. Compost fertilizer also could help improve agricultural production and improve soil structure – which means it offers a longer term advantage over other non-compost mineral-based fertilizers. The high percentage of organic material that is disposed as trash suggests that composting could be a viable municipal solid waste technology.

In practice, composting is not a widely employed technology. Greater use of composting requires analysis of the different levels of technical sophistication and the potential transport capacity of Accra's waste

collection system. Profitability and investment analysis for constructing and operating compost facilities in Accra would have to be undertaken. Such forms of analysis have actually been done as recently as 2004. The results show that the overall cost of building and operating composting facilities in the Accra-Tema Metropolitan area is much lower than for incineration and land filling.³⁷ There are two active compost plants active near Accra. These plants are capital intensive and require very few men for efficient production. It is not fully clear why composting plants are not used and encouraged more. Its current use may be a product of historical artifact. An alternate explanation identifies its limited use as stemming from its sensitivity to the cost of business transactions.

The actual process of composting requires very little manpower, however because Accra's domestic waste is not segregated at the community level, laborers need to be hired to do the initial sorting (i.e. make sure no large pieces of metal are included). This raises the cost of compost production. The price of compost is also sensitive to transport costs. As Accra has grown and expanded, agricultural end destinations for compost have become further and further removed from the site of compost production adding to the expense of compost purchasing. The current preference of non-composting waste management technology may be difficult to adjust considering these circumstances, which is a shame as many urban farmers (inexperienced and experienced) have positive perceptions and are willing to use compost.³⁸ One potential solution to this impasse is using farmer associations (already in existence) to purchase compost in bulk to reduce transport costs.³⁶ Until transport costs are reduced, composting will likely remain low on the priority list of technological processes expected to ameliorate the waste management burden in the future.

Recycling:

Only 2% of the solid waste is recycled at a recycling facility. Recycling is practiced informally, but the recycling base of Ghana is in general weak. Households in low income areas do not dispose of plastics, bottles, paper, cardboards and cans readily.³ Recyclable materials are used and reused for domestic purposes and only thrown away when they are no longer of any use to the owners. In high income areas, domestic servants will sell these materials to middlemen to supplement income instead of disposing them along with the other refuse. There are two main recycling plants in operation in Accra. Although more waste is generated than can be collected, both recycling plants have been operating under efficiency for years because the waste materials are not separated at the source. Unlike other poor cities around the world, Accra lacks a substantial sector of waste pickers to collect and sort household waste on behalf of merchants, recycling firms, and composting units.²⁹ Encouragement of the waste picker labor market and other participants in the informal recycling sector could help extend the lifespan of the cities landfills through waste diversion.

Incineration:

Incineration is a method of burning waste that is combustible at high temperatures in the range of 1000 degrees Celsius to reduce the waste to ashes.³⁹ It is used primarily as disposal for biological waste associated with medical care. Policies governing the appropriate use of incineration exist in Ghana, but Accra incinerators mostly consist of ovens or open pits used to burn bandages and blood products.⁴⁰ After burning, the ash is usually moved straight to an adjacent landfill, where it takes up only a tenth of the volume of the original waste. Ghana's national policy recommends small scale incineration plants, but primarily as a disposal option for health care wastes.

Research Needs:

Recycling :

Landfills and dump spaces are diminishing. Although new ones are being constructed to expand short term capacity (and long term capacity if new landfill sites can be successfully maintained), it may be prudent to look for long term waste management strategies contextualized to the needs and dynamics of urban Ghana. One potential avenue for exploration is to determine if recycling can play a larger role in the disposal practices of Accra residents. Currently only 2% of Accra waste is recycled. Recycling is not promoted at the state or local executive branch reflecting the focus on waste collection and disposal. However the success of other sub-Saharan recycling projects⁴¹ (Rwanda Solid Waste Collection and Biomass Recycling Project) suggests that it may be a realistic possibility for sustainable waste reduction. Local plants complain that they have to clean and sort recyclable refuse – all of which add to the cost of recycling. If residents could be motivated (not simply educated) to sort goods before disposing of them, it could lower the cost of business and perhaps make recycling a more lucrative and effective industry worthy of more state support.

Labor Input Research:

Public apathy to environmental issues prevents residents from making meaningful contributions to the difficult decisions that are required to prioritize environmental health. Historically, community participation in Accra municipal decisions has been low. Accra lacks the resources to organize dialogue sessions, and rarely employs facilitators to involve people in decision making.⁹ On occasion, groups of residents have been mobilized to remove waste and dechoke gutters after a rain storm during rainy season. While the urgency of a choked gutter is heightened by the threat of an oncoming storm and possibility of flood, it is not difficult to motivate citizens to act. But perhaps this same fervency might be harnessed to provide more regular debris removal from blocked gutters.

It seems poignantly incongruous that there exists simultaneously so many people seeking work and also so much potential for physical labor to raise basic environmental health standards. Labor is one of the most available inputs in Ghana's waste management sector. It is certainly more readily available than capital stock and imported technologies. But no institute has responsibility for research into Accra's major resource—its people. A major research effort on the economics of the waste management labor market is needed to determine if substantial gains in output, employment, and services can be had from the introduction of labor-intensive methods of waste collection and disposal (ex: the use of handcarts to retrieve garbage from collection points not reachable by trucks). It is possible that short-term efficiency gains could be had if waste companies used a higher ratio of labor to capital.

Community participation is vital for all these proposed plans of action. The literature is replete with examples of projects that have yielded sustainable results from community organizing efforts. One of the most successful examples is the Orangi Pilot Project⁴² in which residents of Karachi Pakistan slums were given the capacity to participate effectively in the creation (purely community financed and constructed) of their own sewage system. It is crucial to create and access a self-referential body of research (through focus groups, small scale pilot projects, and published studies) to help determine if similar initiatives are applicable to the environmental conditions in Accra. These research demonstrations can help guide citywide policy and highlight how best to engage with the city's poor communities.

Landfill Gas Recovery Research:

A technological intervention with the potential for long term impact on Accra's waste management woes is landfill gas recovery. At sites with large inputs of commercial and industrial organic waste, large amounts of methane gas are produced. Methane gas can be captured and fed to gas wells used to generate electricity. This technology is already in use in the developed world. The first Landfill gas capture project was recently started in South Africa and is currently entering phase 2 of its completion. Already electricity is

being produced and sold to the local population to generate revenue.⁴³ Additional revenue is being received from carbon credits that can be sold on the carbon market through the Kyoto Protocol.

While landfill methane capture will not reduce the amount of waste generated, it can serve as a potential source of energy for local residential and commercial buildings. Additionally, it can lower environmental risk by lowering overall emission of methane. Methane, the second most important greenhouse gas after carbon dioxide, has a global warming potential that is 23 times that of carbon dioxide. Landfill gases contain approximately 50-60% methane with the remainder primarily carbon dioxide. Because methane has an atmospheric lifetime of 12 years, reducing its emission from landfills can make a significant impact on atmospheric concentrations.

The utilization of such a technology in Ghana would allow citizens to make more use of the landfills by harnessing the effort put into collecting and storing garbage and transforming it into needed power supply. Currently, landfill electricity-from-gas generation projects in Africa are not competitive with local electricity costs. In South Africa for example, the gas-recovery landfill in Durban is 66% more expensive than the current electricity supply. However the landfill construction is funded from the Worldbank's Prototype Carbon fund – a recently available form of finance provided from carbon credit market. Under the United Nations' Clean Development Mechanism, companies can invest in clean energy projects in poorer countries like South Africa, and in return get offset credits which can be used toward emissions goals or sold for profit.⁴⁴ As one of the designated host countries for these technologies, Ghana stands to benefit from research into innovative projects like the gas-recovery landfill in South Africa if only investors can be attracted to the waste management sector.

Conclusion:

Domestic waste management has been a persistent problem in Accra for years. The current system of disposing waste on empty land is unsustainable. A more acceptable and safer means of waste disposal needs to be introduced. To cope with the present and future challenges of waste management, the AMA will need to play a role in creating a culture of waste reduction supported at the community level. The development and importation of technology that will improve the long term sanitation environment will have to be facilitated at the state level. The municipal government is not designed to fund the creation of engineered sanitary landfills or support experimentation with other terminal waste disposal technologies. Until budgetary allocations can be sufficiently increased, AMA may do well to consider adopting an economic funding model (raising fees on high-income households to cover the services of low-income neighborhoods) that facilitates broad service coverage. These approaches will undoubtedly take years to mature. A present improvement in waste management conditions will require the participation of new actors.

Unemployed residents of the capital may have a role to play here. There is vast potential to engage the citizens of Accra in improving the provision of environmental services. The literacy and environmental awareness of the needier communities may be too low to support the creation of environmental care groups and neighborhood task forces. Still the sheer availability of physical capital, the high unemployment rate of the city, and the urgent need for better waste management call for a solution that is in part labor intensive. Labor intensive policy can range from a mass mobilization of city residents to unclog drains to using health workers to teach container composting as healthier alternative to refuse dumping.

Questions will arise about the appropriate role of Accra residents in managing their local waste environment. Since the inception of Ghana as an independent sovereign state in 1957, social services have been seen as the purview of the local government. Solid waste collection has been historically viewed as a government provided social service. Nonetheless, a shift in contours of the public and private domain will have to occur.

Recent policy directives and legislation suggest the AMA is at the very least interested in taking small steps that will place Accra's waste sector on the road to sustainable development. The range of options available is at present constrained by technical knowhow and financial support of the state administration. But even within these constraints, the extent to which AMA can implement preferred technologies will depend on the greater participation of the residents it serves. For better or worse the future of Accra's waste management services is irrevocably tied to the involvement of the public. Neglect of these potential actors will result in severe consequences for the capital's environment health.

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