

Research paper

## The world's electronic graveyard: What is the solution to Ghana's e-waste dilemma?

Anne Canavati<sup>a,\*</sup>, Jayson Toweh<sup>b,1</sup>, Adam C. Simon<sup>c</sup>, Brian K. Arbic<sup>c</sup><sup>a</sup> Program in International and Comparative Studies, University of Michigan, Ann Arbor, MI 48109, USA<sup>b</sup> Program in the Environment, University of Michigan, Ann Arbor, MI 48109, USA<sup>c</sup> Department of Earth and Environmental Sciences, University of Michigan, Ann Arbor, MI 48109, USA

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### 1. Introduction

This case was developed as a teaching tool for undergraduate students to determine potential solutions to the environmental and health issues resulting from the informal electronic waste (e-waste) recycling sector in Accra, Ghana. Students are introduced to the concept of e-waste through the lens of individuals for whom e-waste is a primary source of income. Students are asked to think about the flow of e-waste from more developed to less developed countries and discuss realistic solutions to transitioning the recycling of e-waste from current practices that are hazardous to the health of the artisanal recyclers to a system where their health is not jeopardized, and jobs are created. The case study was based on real circumstances observed by the authors during interviews with artisanal e-waste workers in August 2016 as well as interviews with government officials and other local stakeholders. We anticipate that instructors will assign this case to students and have them read through the material as preparation for engaged dialogic teaching with the instructor.

In Ghana's capital city, Accra, an influx of e-waste from more developed countries beginning in the early 21st century created a growing artisanal recycling industry where residents remove metals such as copper from nonworking electronic products including cellular phones, computer monitors, televisions, refrigerators and even school buses (Amankwaa, 2013). The metals are sold to a local buyer who then resells the metal for a profit and the metal ultimately makes its way back into the international supply chain and into new electronic products sold

around the world. This artisanal recycling operation takes place in an area of southeast Accra called Agbogbloshie, which was once a lush marshland, but is now a nearly 70-acre e-waste dump (Amankwaa, 2013). Agbogbloshie also hosts an open-air farmers market that is frequented by community members (Amoyaw-Osei et al., 2011). Though the presence of the e-waste dump represents a public health crisis, e-waste artisanal recycling has become an integral part of the local economy providing jobs and a relatively reliable source of income for many workers from the agriculture industry who come to Accra in search of work during the off-season (Amankwaa, 2013). The resale of scrap metals and components from dismantled electronics provides income to artisanal recyclers but this occurs to the detriment of the health of surrounding communities and has resulted in significant environmental degradation (Amankwaa, 2013).

In 1957, Ghana was the first African nation to gain independence from European colonialism after nearly three-quarters of a century as a British Crown Colony (Agyei-Mensah & Aikins, 2010). Ghana subsequently made major strides in building municipal water infrastructure, which reduced water-borne diseases and led to population growth (Agyei-Mensah & Aikins, 2010). The rapid population growth eventually led to housing shortages as well as environmental quality issues (Agyei-Mensah & Aikins, 2010). This created an unstable political environment, and from 1972 to 1982 Ghana had more than six governments (Agyei-Mensah & Aikins, 2010). The political instability resulted in significant deterioration of public health services (Agyei-Mensah & Aikins, 2010). The International Monetary Fund (IMF) and

\* Corresponding author.

E-mail address: [annecan@umich.edu](mailto:annecan@umich.edu) (A. Canavati).<sup>1</sup> Present address: Program in Environment and Resources, Stanford University, Stanford, CA 94305, USA.

the World Bank intervened by devaluing currency, reducing inflation, and decreasing government spending on health, education, and welfare (Konadu-Agyemang, 2000; Briggs & Yeboah, 2001; Yeboah, 2003; Agyei-Mensah & Aikins, 2010). While the actions of the IMF and World Bank prevented economic collapse, these programs resulted in the loss of 300,000 public sector jobs and reduced educational opportunities throughout Ghana (Agyei-Mensah & Aikins, 2010). The loss of jobs and educational opportunities in turn led to the migration of people from rural communities, mostly from the agricultural north of Ghana to Accra where they sought new economic opportunities (Grant, 2006; Amoyaw-Osei et al., 2011).

Sparse job opportunities in Accra for newly arrived persons from rural areas of Ghana coupled with the proliferation of imported used electronic devices led to e-waste recycling in Agbogbloshie (Amoyaw-Osei et al., 2011). Many of the rural migrants settled in Agbogbloshie (Amankwaa, 2013), a large slum settlement, where beginning in 2005, scrap dealers collected and sold metals and materials from nonworking electronic devices (Amoyaw-Osei et al., 2011). Artisanal e-waste recycling is performed in open space adjacent to the Korle Lagoon, which separates Agbogbloshie from the Old Fadama slum (Farouk & Owusu, 2012). The Korle Lagoon has received international attention as one of the most polluted bodies of water in the world (Environmental Justice Atlas, 2017). At times, Agbogbloshie and Old Fadama are occupied by more than 100,000 people, many of whom are engaging in e-waste dismantling or related artisanal work (Lidman, 2016). These individuals, including many boys and young men, are exposed to toxic smoke, chemicals that leach into drinking water, malaria-carrying mosquitos, and other infectious diseases (Amankwaa, 2013). The artisanal work yields on average \$1.25 per day per worker, and that revenue is often sent home to families in northern Ghana (Schluep et al., 2012). Despite living in the capital city where one might assume job opportunities exist, the absence of jobs in a formal economy and lack of training opportunities leaves artisanal recycling as a primary source of income for residents of Agbogbloshie (Amankwaa, 2013).

Though the negative environmental and health impacts of informal e-waste recycling are well characterized and understood by government officials, there is a dearth of documented evidence for public policy to regulate artisanal recycling or limit the import of used and nonworking electronic devices into Ghana, which lacks the infrastructure to properly process and recycle e-waste (Amoyaw-Osei et al., 2011). The Basel Convention, which was ratified in 1989, established a framework that governs the transfer of hazardous waste within, between, and among countries (United Nations Environment Programme, 2018). As of 1989, 172 countries had signed onto the Convention; however, the United States had not (Bennion, 2011). In 2002, the Basel Convention was adopted at the 6th meeting of the Conference of Parties as a solution for the growing e-waste problem that affected Ghana and many other less developed countries (United Nations Environment Programme, 2003). In 2019, the Ban Amendment for the Control of Transboundary Movements of Hazardous Wastes and their disposal became international law. The Ban Amendment explicitly prohibits hazardous waste exports to developing countries from Member States of the Organization for Economic Co-operation and Development (OECD), the European Union (EU), and Liechtenstein (Neha, 2010).

The following narrative provides an overview of the state of artisanal e-waste recycling in Accra, Ghana. The material presented here is based on interviews by the case authors of various stakeholders at Agbogbloshie as well as government officials, university professors, non-profit advocates, formal waste professionals, and e-workers. The case study provides a variety of perspectives and challenges the reader to critically evaluate proposed policies and programs that have the potential to improve the health and wellbeing of residents of Agbogbloshie and the local environment.

## 2. Overview

This case study traces the life cycle of used electronic devices that are imported to the African nation of Ghana from more developed countries such as the United States, Canada and the EU. Unusable, nonworking electronics are colloquially referred to as “e-waste” and after being imported to Ghana ultimately end up at the Agbogbloshie scrap yard in southeastern Accra approximately 3 km from the central business district (Al Jazeera, 2015) (Fig. 1). At Agbogbloshie, the electronic devices are physically dismantled by informal workers who seek to extract and sell metals such as copper that are components of the e-waste. E-waste recycling methods include burning plastic and insulation tubing on metal wires to access copper. Burning the combustible plastics releases harmful pollutants into the air, soil, and lungs of those living and working in and around Agbogbloshie. The effects of these unregulated practices directly impact over 90,000 individuals in the area as well as tens of thousands of other Ghanaians who consume food products from the area. The lucrative and intricate informal e-waste recycling sector has grown large and out of control in the eyes of government officials. However, local and national government entities lack the funding and political pressure to regulate the industry. The devastating impacts on the local environment and horrific public health hazards for residents and e-waste workers require action and yet there is very little evidence for action being taken by any of the stakeholders to mitigate the problems.

The interviews and site visits for this case study were conducted in August 2016. The views, statements, and conclusions are solely those of the case study authors. Any organizations or names listed in this case study do not necessarily agree with the contents of this article.

## 3. Part 1: The National Youth Authority’s Agbogbloshie problem

To say that the Director of Technical Projects at Ghana’s National Youth Authority (NYA) was overwhelmed by the challenge confronting him would be an understatement. As an official with the NYA, which operated within the Ministry of Youth and had a “mandate to ensure the empowerment of the Ghanaian youth,” the Director’s goal was to promote health, education, and development for Ghanaian children and young adults (NYA, 2020). As one avenue for realizing this goal, the NYA acquired in 2006 the title to the land that constituted Agbogbloshie with the intention that its 70 acres would be a recreational area for Accra’s urban youth. At that time, the goal was realistic. However, over the decade that followed that land acquisition, Agbogbloshie transformed into one of the most toxic e-waste sites in the world (Ahmed, 2016), and the NYA was confronted with the challenges of how to reclaim the heavily degraded land and what to do with the more than 100,000 individuals who relied on informal e-waste recycling for their livelihoods.

Agbogbloshie was once a lush wetland positioned on the banks of the Odaw River near the Korle Lagoon. It was a hub for fisherman and was inhabited by the indigenous Ga people of the Ga-Dangbe group of the Kwa people (Reindorf, 1895; Stacey and Lund, 2016). Following on a long history of land struggles in the area (Grant, 2006), the NYA had originally hoped to relocate the tribal Ga people in order to reclaim the land for its youth development projects. However, the lack of funding, coupled with the rapid expansion of e-waste recycling at Agbogbloshie, severely impacted those plans. Now, the NYA had begun to think that Agbogbloshie might never become a youth area. What could the NYA do? How could NYA reclaim the land and repurpose it for a recreational area without also displacing tens of thousands of Ghanaians who relied on the revenue from the informal e-waste recycling economy to survive? Was the solution to push ahead anyway and block e-waste recycling, or to attempt to accommodate it in some form in the redevelopment? And whatever was decided, where would the NYA find the necessary partnerships to make this decision a reality? The NYA had a lot to consider.

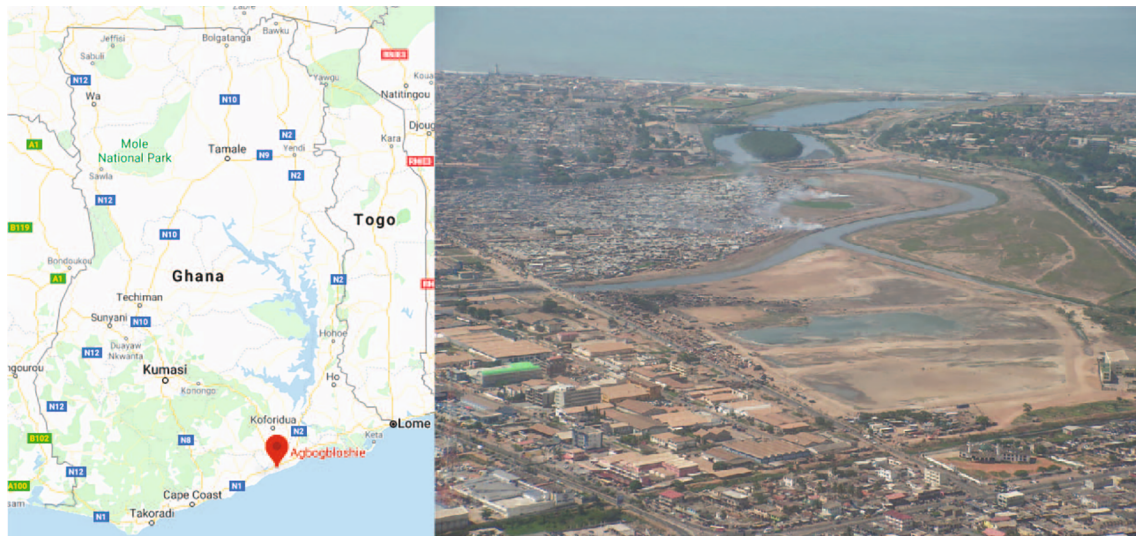


Fig. 1. Location of the Agbogbloshie area in southwest Accra, Ghana (source: google maps), and aerial view of the Agbogbloshie area of Accra, Ghana taken in 2005 (source: By finnish eye - korle lagoon, CC BY-SA 2.0, <https://commons.wikimedia.org/w/index.php?curid=15233960>).

#### 4. Part 2: The birth of an informal economy

E-waste recycling began in 2005 as a small-scale operation at Agbogbloshie with only a handful of artisanal scrap dealers. However, it rapidly ballooned into a massive, intricate system that became an economic magnet for impoverished boys and men from across Ghana. E-waste recycling provided just enough money to survive, and more than they could make in other sectors, such as farming. The daily activities of dismantling, burning, and disposing of nonworking electronic equipment quickly degraded the natural environment at Agbogbloshie. Wood chips were dumped throughout the area to elevate the land and keep it from submerging into its natural state as a wetland and floodplain. Mixed with the soggy wood chips were all kinds of plastics, glass, and worthless metal scraps left behind from the electronics that had already been dismantled. Most of the area transformed into a hazardous dump of electronic and human waste. The neighboring slum, Old Fadama, quickly grew beyond the control of the government as an increasing number of Ghanaians from the agrarian north migrated to Agbogbloshie in search of the financial opportunities created from e-waste recycling. The growth of e-waste recycling at Agbogbloshie presented the NYA with a major dilemma in carrying out their development projects since it indeed provided economic opportunities that would not otherwise be available to Ghanaian youth.

The e-waste recycling sector at Agbogbloshie expanded uncontrollably over the course of a decade because of the significant increase in e-waste imported to Ghana, coupled with concurrent domestic conflicts. The global surge in electronics consumption beginning in the 1980s resulted in the rapid consumption of electronic equipment that eventually stopped working or quickly became obsolete and was replaced with newer technology (Fig. 2). Continuous innovation shortened the lifetime of electronic equipment, as products were intentionally manufactured to have short working lifetimes, and there was a commercial lure to get “the next big thing.” For example, major cellphone carriers in the United States typically allowed for device upgrades every two years or less, and used phones were rarely disposed of properly. As a result of demand penetration for electronic devices in more developed countries, the consumer electronics sector experienced compounded growth of about 10% annually between 2010 and 2020 (Damadoran, 2020). This annual growth is expected to continue to increase as technology that has been common in more developed countries for several decades penetrates into the daily lives of citizens of less developed countries such as Ghana. This, in turn, will result in increased e-waste.

Globally, more than 50 million tons of electronic products are

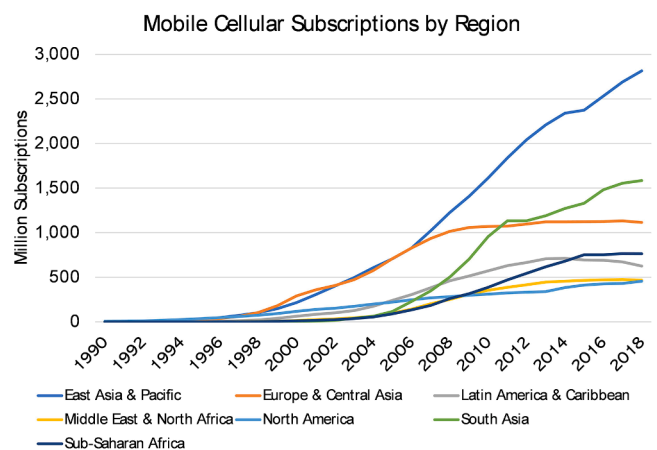


Fig. 2. Mobile Cellular Subscriptions by Region (Source: Anne Canavati using data from the World Bank, 2020, <https://data.worldbank.org/indicator/IT.CEL.SETS?end=2018&start=1960&view=chart>).

discarded annually (Ryder and Houlin, 2019). In Europe, the production of e-waste increased by 45% in the period between 1995 and 2020 (Eurostat, 2019). Increased production of e-waste resulted in a variety of environmental issues. For one, consumer electronics contained raw materials that were limited in quantity and, as such, these materials were increasingly consumed in the production of electronics. For example, a smartphone contains almost seventy different metals, including precious metals such as gold (Rasmi, 2019). Another challenge was the environmental hazards posed by the improper disposal of electronics, since e-waste contains materials such as plastic, aluminum, lead and silica that negatively impact human health if not properly handled (Agyei-Mensah and Oteng-Ababio, 2012). While methods and technologies for the proper disposal of e-waste have been used in more developed countries for several decades, their significant cost at scale resulted in most e-waste being packaged and sold for export to less developed countries. However, some companies were starting to take steps in a more positive direction. Apple, for example, pioneered sustainable processes for recycling used and nonworking iPhones by launching its disassembly robot, Liam, as a part of a larger environmental campaign to reduce, reuse, and recycle the precious materials contained in each iPhone (Apple Sustainability Report, 2009).



Apple's initiative was a step in the right direction, but much of the e-waste produced globally continued to be exported for unregulated disposal. The United States, for example, continued to export 50–80% of the e-waste that was supposedly collected to be "recycled." That e-waste was imported by less developed countries in Africa, Asia, and Latin America, where it had negative impacts on human health and the environment (MONiTOUR E-trash transparency project, 2020). The US was one of the only countries in the world that did not officially join the Basel Convention (Fig. 3), an international treaty created in 1989 that provided the framework for the proper transfer of hazardous wastes within, between, and among countries that were party to the convention. The UK and most of Europe did officially join the Basel Convention and therefore had tighter restrictions on exporting used electronics. Despite this, a Greenpeace investigation in 2005 found that about 47% of waste exported from 18 European seaports was illegal (Greenpeace, 2009). Further, because the convention was not legally binding in international law, adoption of its framework varied widely. The result was inconsistent implementation, especially in less developed countries.

The absence of a legally enforceable framework for the international trade of e-waste presented a significant challenge for the NYA. For Ghana and other less developed countries who lack the economic and political power of the United States, Canada and the EU, their unequal status within the broader power system of global relations created a huge problem. At the same time, however, the importation of e-waste created new economic opportunities for tens of thousands of impoverished Ghanaians. At the same time that e-waste imports proliferated, ethnic conflict in northern Ghana resulted in the displacement of members of predominantly Muslim communities who migrated south to Accra (Debrah et al., 2016). This created the perfect ecological and public health storm as newly arrived, displaced Ghanaians entered the artisanal e-waste trade as it provided them an economic foothold in Accra. This has now resulted in Agbogbloshie establishing itself as the largest e-waste recycling network in Africa.

### 5. Part 3: Tracing the supply chain

#### 5.1. Port of entry

The e-waste that is sifted through and dismantled at Agbogbloshie moves from global to local supply chains when it enters Ghana at the Port of Tema, located 25 km up the Atlantic coast from central Accra. Tema receives approximately 85% of Ghana's imports as well as goods destined for landlocked neighboring countries, such as Niger, Mali, and

Burkina Faso. In 2015, Ghana imported around 10 million tons of goods through the Tema port and approximately 215,000 tons of the total imports were in the form of used electronic goods ranging from smartphones to televisions to household appliances such as ovens, washers, dryers and refrigerators. Estimates of the amount of imported secondhand electronics that were immediately usable or repairable in comparison to those that were irreparable varied among different sources. An e-waste assessment conducted by a collaboration of multiple NGOs in 2011 reported that "about 70% of the imports arrive[d] in a working condition, about 20% [could] be serviced (repaired/refurbished) to get them functioning, and about 10% [did] not function" and immediately became part of the e-waste trade (Amoyaw-Osei et al., 2011). It was generally assumed by most people familiar with the e-waste trade in Accra that most of the nonworking and irreparable electronics quickly wound up at Agbogbloshie. The imported secondhand electronics that were repairable to working condition created their own job market for workers who refurbished electronic goods for resale in domestic markets. Such repairs allowed the electronics to function for an unknown amount of time before they ultimately became e-waste and ended up at Agbogbloshie.

Despite the challenges that e-waste presents in less developed countries, the import of secondhand electronics is important considering that the vast majority of Ghanaians cannot afford new electronics and therefore rely on access to refurbished laptops, smartphones, televisions, and automobiles. Secondhand shops throughout Accra sold and refurbished everything from small handheld electronics to kitchen appliances and vehicles. This market for secondhand electrical equipment serves an important role in closing the digital divide between more and less developed countries, since refurbished smartphones and computers provide Ghanaians with access to information, resources, and professional and educational opportunities. For instance, the manager of the nonprofit organization Black Star Solar located on the outskirts of Agbogbloshie relied on a secondhand, refurbished laptop for business because buying a new laptop was prohibitively expensive. Black Star Solar was a neighborhood organization that provided low-cost solar lighting to businesswomen in the Old Fadama slum adjacent to Agbogbloshie. For this reason, the organization was an important partner in empowering the residents of the area and improving their lives. This was but one example of the many companies and individuals that relied on refurbished electronics and highlights the importance of importing used, refurbished electronics that are essential for economic growth.

Nonetheless, there were still negative aspects of the importation of so many secondhand electronics—the most obvious being the amount of

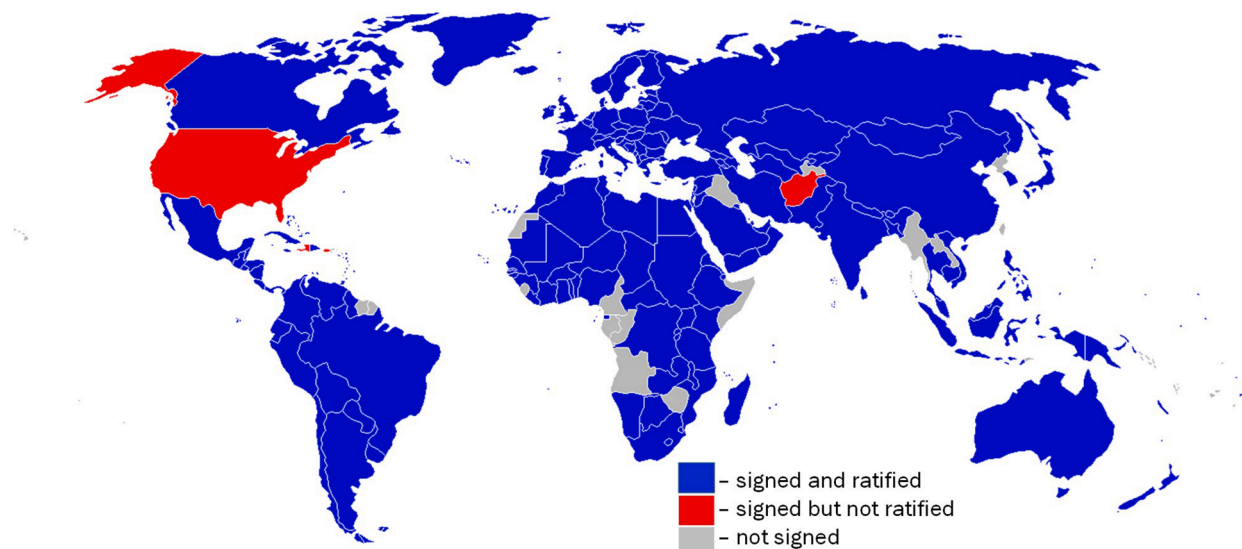


Fig. 3. Basel Convention signees. (Source: [https://upload.wikimedia.org/wikipedia/commons/1/1c/Basel\\_Convention\\_signatories.PNG](https://upload.wikimedia.org/wikipedia/commons/1/1c/Basel_Convention_signatories.PNG)).



irreparable e-waste that accompanied the usable electronics as well as the amount of e-waste generated within Ghana because of the abbreviated lifetimes of refurbished electronics. Some organizations observed that “donations” of used electronics had become a guise for the illegal export and dumping of e-waste in less developed countries by more developed countries trying to avoid violating the Basel Convention. According to the Ghana Ministry of Trade and Industry, there were controls in place to regulate and monitor the contents of all goods entering the country. However, it was simply impossible to check the functionality of each individual electronic item that arrived at the Port of Tema. At the very least, all containers were required to be labelled with their contents, and items such as secondhand refrigerators and air conditioning units had been banned from importation because they contained hazardous chlorofluorocarbons (CFCs).

Further restrictions were enacted as of July 2016 after the Ghanaian Parliament passed the Hazardous and Electronic Waste Control and Management Act that adopted the provisions of the Basel Convention (GOGLA, 2016). That Act has the goal of limiting and restricting the amount of hazardous waste imported into Ghana and requires manufacturers and importers of electrical equipment to register the electronics with the Ghanaian Environmental Protection Agency (EPA), which would then establish a levy for all imported electronic products. Over \$100 million USD was expected to be generated by this new law. The money collected from the levy would be used to create treatment and collection facilities to recycle the e-waste in an environmentally responsible way. Violators faced heavy fines and jail sentences of no less than one year. Additionally, individuals would be able to sell their unusable and irreparable electronics at new recycling facilities where the e-waste would be safely dismantled, and either recycled or properly disposed of in a landfill. The goal of the Act was to “prohibit the importation, exportation, transportation, selling, purchasing, or dealing in or depositing of hazardous waste or other waste on any land in the country or in the territorial waters of Ghana.” (GNA, 2016). Local stakeholders were pleased with this step to regulate and reduce e-waste, but its impacts had yet to be felt at Agbogbloshie, and it therefore offered little help in reclaiming the land in the near term.

## 5.2. The collectors

The NYA understood that it had to take into consideration not only the global and local supply chains through which used electronics reached Agbogbloshie, but also the local livelihoods that were supported by e-waste recycling on the land it wished to reclaim. Because most Ghanaians owned used electronics, there was a high turnover rate as secondhand goods stopped working and became unusable after only a few years. Most of the electronics in Agbogbloshie began their journey to their final resting place through the work of e-waste collectors who traversed the streets of Accra asking individuals, businesses, and shops for unusable electronics. One such e-waste collector, Hassan, described his daily routine as follows: Hassan woke up early to begin his day and was usually out on the streets of Accra by 7:00 AM pulling his “truck,” a pull cart made from dismantled car parts (Fig. 4). Hassan walked throughout Accra going door to door to homes and businesses in search of broken electronics that he could then take to Agbogbloshie, where the electronic products would be dismantled and their metals removed (Fig. 5). Hassan might, for example, buy a broken laptop for around five cedi (\$1.25) and load it onto his truck, which might also contain televisions, computers, stoves, and small appliances such as toasters and coffee makers.

Such collection of electronic goods was a relatively low-risk job within the Agbogbloshie e-waste recycling industry and the economic reward was correspondingly small. On a good day, Hassan might earn the equivalent of around US\$2, and on the worst days he might earn nothing. The inconsistent nature of this work made it very hard sometimes for Hassan to justify being in Accra, away from his family in northern Ghana. As the oldest boy in his family, 19-year-old Hassan had



Fig. 4. Vehicle used to transport electronic waste to Agbogbloshie. (Source: Anne Canavati).



Fig. 5. Television and computer electronic waste from which metals are extracted. (Source: Anne Canavati).

to earn enough money to send to his parents, grandparents, and siblings to sustain their lives. Hassan typically returned to his village every three months to help his family with crop harvests on their farm. During the dry season, Hassan and many other boys would come to Agbogbloshie in the hopes of saving enough to help their families.

Once Hassan filled his cart with nonworking electronic devices, he would take his collection of e-waste to the area along the Odaw River in Agbogbloshie where scrap dealers operated. There Hassan would negotiate a sale and turn over the e-waste so that it could be dismantled.



Some collectors did the dismantling themselves, but Hassan preferred to sell the products to the middlemen rather than having to work with broken glass, plastics, and toxic components. After Hassan was paid for his electronic goods, he would call it a day. The personal experiences of young Ghanaians such as Hassan made it difficult for NYA officials familiar with the neighborhood to move forward with plans to reclaim Agbogbloshie, acknowledging the financial hardship it would place upon those who relied on revenue from e-waste for their livelihood.

### 5.3. The dismantling

At Agbogbloshie, loud clangs filled the air as the dismantlers hit and broke TV screens, monitors, and other electronics. Some men hit metal components of car engines together to access the copper wire wedged tightly between metal pieces. There were always many physical hazards present amid the unregulated hitting, throwing, and breaking of glass, plastic, and metal. To add to the health risks, toxic liquids such as mercury, and melted lead and cadmium were often expelled from computer circuit boards and batteries during the dismantling process. The combination of physical and chemical hazards created a dangerous environment in which workers were constantly under distress from a multitude of harmful exposures.

Once the e-waste was dismantled, the readily available parts were gathered to be sold to “the Nigerians,” who, according to the Ghanaian e-waste workers, were described as the smart businessmen of the scrap yard. The e-waste workers communicated that the Nigerian men were “very wealthy” as they bought the scraps from the workers at Agbogbloshie and engaged in wholesale trade of the recycled components, likely to markets in Europe. The daily activities at Agbogbloshie were purportedly overseen by the Chairman of the Agbogbloshie Scrap Dealers Association (ASDA), who was referred to as “the Chairman” and set regulations for anyone wishing to enter and/or work within the scrap yard. The ASDA was an organization that e-waste workers could join for a fee of about \$1, after which workers were supposedly provided with insurance or bailouts if they were unable to make money on a given day. However, there were mixed opinions about whether the Chairman had the best interests of the e-waste workers in mind, which added concerns about corruption to the complex governance situation at Agbogbloshie.

A handful of nonprofit organizations have attempted to mitigate the public health and environmental degradation at Agbogbloshie. For example, Agbogbloshie Makerspace Program provided funding for a facility that was intended to be used as an innovation hub for training for e-waste workers in collaboration with research scientists and students (AMP, 2018). However, the built structure was never used as intended and was dilapidated and not in use when the authors visited in 2016. The Chairman communicated to the authors that the structure served no purpose for the e-waste workers. Another nonprofit called Pure Earth provided a copper wire stripper to reduce the e-waste workers’ reliance on a very harmful practice at Agbogbloshie—burning the insulation from wires (Sim, 2015). However, the wire stripper did not work with the very small wires found in handheld electronics and it negatively impacted the e-waste workers’ ability to recover copper. As a result, the e-waste workers continued to use open fires to burn plastic off of electronic products and used their bare hands to extract the metal after the plastic insulation was burned off. Without any doubt, these and other efforts by nonprofit organizations were done with the best intentions. However, there was no evidence that the efforts produced tangible results that mitigated the most pertinent health and safety concerns.

### 5.4. The final resting place

One of the biggest public health and environmental concerns at Agbogbloshie is the large amount of air pollution produced by the regular practice of burning the plastic insulation from metal wires (Fig. 6). E-waste workers engage in this practice to obtain copper that they can sell to middlemen. After burning the plastic insulation that surrounds



Fig. 6. Men burning plastic sheathing to expose copper wire. (Source: Anne Canavati).

the metal wires, workers would pick through the copper with their bare hands to remove any plastic ash residue. To clean the ash from the burned copper, a worker would hit the bundle of ashy wires, copper, and charcoal with a rock using his bare hands. One scrap dealer, Mohammed, reported that he had done this work for five years. Like many workers who came from northern Ghana, he worked seasonally, alternating every three or so months between helping with farming in his village and coming to Accra to work at Agbogbloshie. He hoped to earn enough money to open a convenience shop in his village, but it was hard



Fig. 7. A bag of copper recovered from electronic waste after burning plastic sheathing. (Source: Anne Canavati).

since he earned less than \$2 per day for a bag of copper (Fig. 7).

The significant health risks of burning the plastic insulation as well as touching and working with toxic materials without gloves, masks, closed-toe shoes, or proper working attire are well documented (Verma et al., 2016). Those authors report that breathing in the toxic smoke from burning plastic in open areas such as Agbogbloshie can lead to a variety of pulmonary problems, including acute respiratory infections, bronchitis, and fibrosis, the development of scar tissue in the lungs. In the long term, bronchitis can lead to chronic obstructive pulmonary disease-causing emphysema, which results in lung destruction and breathing difficulties. It is also possible to develop lung cancer from inhaling the toxic smoke. Some of the most common harmful toxins found at Agbogbloshie are lead, cadmium, and mercury, which all have lethal effects if ingested or inhaled. Exposure to lead negatively impacts human neurological growth, as lead is a neurotoxin that impairs brain development. Extended exposure to cadmium can result in cadmium accumulation in the kidneys, leading to kidney disease. Mercury inhalation deteriorates the nervous, digestive, and immune systems, leaving the workers at a high risk for additional health problems such as infections from daily physical injuries. When cuts, bruises, and burns are left untreated, which was very common due to the lack of affordable healthcare services, such injuries often become infected, creating additional health problems for the potentially immunocompromised workers.

The dismal living conditions in Agbogbloshie and the neighboring Old Fadama slum presented additional lethal health dangers. Because Agbogbloshie is situated on a wetland, the area had become a breeding ground for mosquitoes, many of which carry malaria. The e-waste workers slept outdoors without protection, and thus they constantly risked contracting malaria. There was also no formal waste management system in place, so workers frequently came into direct skin contact with water contaminated by feces and other human and animal waste. For this reason, diarrheal diseases were very common. These health problems were widespread, and very little had been done to mitigate these risks to the workers and residents in the area.

In addition to these impacts on human health—and much more problematic for the NYA's goal of reclaiming the area for recreational use—was the rampant land degradation at Agbogbloshie. What had been a lush wetland and hub for fishermen along the Odaw River was a wasteland when the authors visited in 2016. The ecosystem at Agbogbloshie had been destroyed, and the river, which flowed directly into the Atlantic Ocean, had lost virtually all its aquatic life. Leachate from discarded electronics, printer cartridges, and old batteries seeped into the ground; unregulated dumping practices polluted the land and river; and uncontrolled burning filled the air with toxic fumes that contaminated everything. Thick black smoke from the fires that burned plastic insulation tubing from copper wires made it nearly impossible to breathe. Ashes from the burned materials permeated the ground and mixed with the soil. Soil samples from Agbogbloshie are enriched in heavy metals, some of which are toxic to humans and all life, as well as many organic chemical pollutants (Brigden et al., 2008; Fosu-Mensah et al., 2017). Those studies reported that concentrations of copper, tin, and zinc were more than 100 times greater than the levels considered safe for humans. Even more harmful elements, such as lead and cadmium, were also found at high concentrations at Agbogbloshie.

Unsurprisingly, the environmental pollution and health risks of the informal e-waste industry were not confined solely to the 70 acres of Agbogbloshie. The pollution spread across Greater Accra through air, water, and even food. Across the street from the scrap-dealing area in Agbogbloshie, there was an outdoor market where people from all over Accra came to purchase their produce, meat, grains, and other household staples—all of which were exposed to harmful smoke, air, and water pollution. The 2009 Greenpeace study reported metal concentrations for soil samples collected in the Agbogbloshie market, and the soils contained similarly toxic levels of pollutants. For these reasons, reclaiming the land at Agbogbloshie and cleaning up the e-waste

industry would benefit the wider community of Accra.

## 6. Part 4: One final consideration: The other stakeholders

Several other entities in addition to the NYA had a stake in what happened at Agbogbloshie. The NYA owned the land, but the Environmental Protection Agency (EPA), which operated within the Ministry of Environment, Science, Technology, and Innovation (MESTI), had regulatory authority over the area. The EPA was responsible for involving stakeholders in policies, regulations, and proposals for the reclamation of the area. Considering the 2016 Hazardous and Electronic Waste Control and Management Act, 2016 Act 917 passed by the Ghanaian Parliament and assented to by the Ghanaian President, the Ghanaian EPA is working to establish specific regulations for the importation of e-waste into Ghana, effectively seeking to create a fund that would be used for the collection, treatment, recovery and environmentally-sound disposal of electronic waste (SRI, 2018). The Accra Metropolitan Assembly (AMA), which is the municipal political and administrative authority in the city of Accra, was also involved in regulating activities at Agbogbloshie. One of the many tasks of the AMA is to provide waste management services, although the AMA contracted these services out to private companies such as Jekora Ventures (Jekora Ventures, 2019). Such private waste management companies were assigned specific neighborhoods and regions in Greater Accra where they were supposed to provide waste disposal and, in some cases, recycling services under a variety of pricing schemes. However, low-income areas such as the Old Fadama slum were often overlooked and underserved by waste management companies, and this added to the perfect waste storm by creating the opportunity for unregulated waste disposal at Agbogbloshie. The NYA believed the AMA would be instrumental in helping to oversee the implementation of any changes in e-waste disposal at Agbogbloshie considering that the AMA provided essential municipal services.

Several nonprofit organizations such as Help the African Child Foundation also worked directly with e-waste workers to try to improve their living and working conditions (HACGhana, 2020). However, limited funding and resources effectively rendered these efforts meaningless. Help the African Child and the workers they served had called for specialized trade school facilities to be established in Agbogbloshie to provide opportunities for the workers to become, for example, mechanics, carpenters, or seamstresses. Other NGOs raised funds intended to improve the conditions at Agbogbloshie, but often foreign donations were misguided or out of touch with the real needs of the workers, resulting in little on-the-ground benefit. Sadly, such an outcome of international effort is common and often referred to as “helicopter aid”. The multitude of stakeholders involved muddled the decision-making process as the NYA had to act within this ecosystem of differing organizational motivations and intentions to secure funding, regulatory backing and financial support to mitigate the public health crisis.

## 7. Part 5: The decision

The Director of the NYA had to decide how best to leverage their relationships with other stakeholders to reclaim the degraded land at Agbogbloshie without losing sight of the thousands of Ghanaians who depended on the thriving but destructive informal e-waste economy for their survival. There had been proposals to cut off e-waste at its source—Tema port—but such action would largely hinder the ability of Ghanaian residents of Agbogbloshie to take ownership of refurbished, working electronic goods and engage in modern-day educational, economic, and other professional development via electronics and the internet. Another drastic, localized solution that had been proposed was to bulldoze and destroy the scrapyard in Agbogbloshie. This would, however, disenfranchise thousands of workers such as Hassan and Mohammed and would likely lead the industry to simply relocate elsewhere in Accra. Also, while the NYA could hold out for the possibility



that the Hazardous and Electronic Waste Control and Management Act of 2016 would reduce e-waste importation and formalize e-waste recycling, something had to be done about Agbogbloshie sooner rather than later. The NYA had assessed this dilemma for a long time and considered many different scales, viewpoints, and consequences. A decision had to be made, yet there was no viable solution in sight.

To this day, the smoke from Agbogbloshie continues to hang over Old Fadama as a sickening haze. Somewhere beyond that veil, young men like Mohammed continue to labor in flames and noxious air, and the chemicals that enter their exposed bodies are the next link in a global chain of disposal. In contrast, the blueprints and plans for a clean landscape with modern facilities for recreation and youth programming likely still sit tucked on the shelves at the NYA. As an issue so complex, Agbogbloshie remains an e-waste graveyard for now. It is critical for all stakeholders to adopt best practices as described by Davis and Garb (2015, 2020) to improve conditions at Agbogbloshie.

#### CRedit authorship contribution statement

**Anne Canavati:** Writing – review & editing. **Jayson Toweh:** Writing – review & editing. **Adam C. Simon:** Writing – review & editing. **Brian K. Arbic:** Writing – review & editing.

#### Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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