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Toxic transitions in the lifecycle externalities of a digital society: The complex afterlives of electronic waste in Ghana

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Abstract: This study examines the contours of electronic waste (“e-waste”) governance in Ghana, one of the top five importers of e-waste in the world, as well as the site of one of the most intensive e-waste scrapyards in the world, Agbogbloshie. At Agbogbloshie, despite the intentions of national Ghanaian regulations and hazardous waste laws, most e-waste is untreated or crudely processed via burning or acid baths. These practices release dioxins, furans, and heavy metals into the environment, invariably harming scrapyard workers, their families, and the greater urban community of Accra. However, the scrapyard also provides a critical source of livelihood for some of Ghana’s most poor, vulnerable, and unskilled migrants. The aim and objective of this study is to humanize the conundrums and challenges that e-waste invokes in places such as Ghana. Based on extensive and original field research—including expert interviews, community interviews with scrapyard workers and families, and naturalistic observation at waste sites and other parts of the e-waste supply chain—this study asks: What benefits has e-waste brought communities in Ghana? What risks has it created? And, critically, what policies need implemented to make e-waste more sustainable? It documents ten ostensible benefits of e-waste alongside ten very real and growing risks. Then, it identifies a concert of fifteen different policy recommendations as well as four research gaps. It concludes by emphasizing the duality of the e-waste phenomenon and e-waste policy, and by underscoring the political economy dynamics of e-waste activities and practices.

Keywords: informal recycling; informal economy; Waste Electrical and Electronic Equipment; digital society; electronic waste; digital divide

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1. Introduction

The world is becoming increasingly reliant on electronic devices and the digitization of consumption, technology, and society. Baldé et al. (2017) note that at the end of 2017, roughly half of the world population accessed the World Wide Web and high-speed internet, and most people have access to mobile telephone networks and services. In more concrete numbers: the world counts 7.7 billion mobile cellular subscriptions and 4.2 billion active mobile broadband subscriptions (Baldé et al 2017). Almost half of all global households (48%) have a computer and projections suggested that the value of electronic commerce surpassed \$22 trillion in 2017, with \$3 trillion in business-to-consumer value. As Figure 1 reveals, the population using the internet has grown from 20.5% in 2007 to 48% in 2017; households with internet access have similarly grown from 23% to 53.6% and the number of households with a personal computer has grown from 30.2% to 47.6%.

Figure 1: Percentage of global households with internet access and computers, 2007-2017

Source: Baldé et al. 2017. These trends in access to the internet and household information technologies has ushered in a new age of interconnection, but it also leads to unintended consequences such as voluminous and growing amounts of hazardous electronic waste.

Concomitant with such rapid increases in the adoption of information and communications technologies has been growth in electronic waste, or e-waste. E-waste colloquially refers to various forms of electrical equipment that no longer have value to those who initially purchased them. Given the ubiquity of electronics and digital devices in modern society, flows of e-waste have grown in staggering quantities over the past decade. Using 2016 data, Baldé et al. (2017) report that each year some 44.7 million metric tons of e-

waste are generated, an amount equivalent to about the weight of 4,500 Eiffel Towers, or equal to about 6.1 kilograms per human inhabitant of the Earth. This number, too, is growing rapidly, up from 5.8 kilograms per inhabitant in 2014. Kumar et al. (2017) estimate that the global production of e-waste grows at 3-5% annually. Daum et al. (2017) caution that the amount of e-waste rose by 8 million metric tons last year alone, to a total around 50 million metric tons in 2018. Of this waste, only approximately 20 percent is recycled. Nonetheless, such waste has valuable raw materials and metals within it. Baldé et al (2017) suggest that the total value of materials present in e-waste was about €55 billion in 2016, more than the GDP of many countries in the world. Included in this waste is €8 billion in gold (Milmo 2015).

This e-waste and the wealth embodied within it ends up somewhere, and when it does, it is not socially or environmentally benign. Accompanying these waste flows, or perhaps more specifically within these waste flows, are various components such as batteries, liquid crystal display screens, cathode ray tubes, and circuit boards. Such components have materials with toxic substances including brominated flame-retardants, polychlorinated biphenyls, and toxic metals including lead, copper, mercury, and cadmium (Amankwaa et al. 2017). There is thus an unevenness and environmental health calamity in the production and consumption of e-waste: the main producers are Europe and the United States, but the main receivers or importers are in Africa and Asia. Sthiannopkao and Wong (2018) therefore call e-waste a global “crisis.” Amankwaa et al. (2017) add that in most developing countries, e-waste is also the fastest growing segment of the municipal waste stream.

This study examines the contours of e-waste governance in Ghana, one of the top five importers of e-waste in the world, as well as the site from one of the most intensive e-waste scrapyards in the world, Agbogbloshie. Its primary goal is empirical, to document and confirm the plight of e-waste workers, and to trace broader social trends related to e-waste, in a comprehensive manner. For at Agbogbloshie, despite the intentions of national Ghanaian regulations and hazardous waste laws, most e-waste is treated as general refuse, or processed crudely via burning and acid baths (Sthiannopkao and Wong 2013). Such practices invariably harm scrapyard workers, their families, and the greater urban community of Accra. However, the scrapyard also provides a critical source of livelihood for some of Ghana’s most poor, vulnerable, and unskilled migrants. Based on extensive and original field research—including expert interviews, community interviews with scrapyard workers and families, and naturalistic observation at waste sites and other parts of the e-waste supply

chain—this study asks three questions: What benefits has e-waste brought communities in Ghana? What risks has it created? And, critically, what policies need implemented to make e-waste more sustainable?

In answering these questions, the study primarily seeks to humanize the conundrums and challenges that e-waste invokes in places such as Ghana.¹ Where previous studies tend to look at only the costs and risks of e-waste, this study looks at benefits alongside costs. Where previous studies tend to focus almost entirely on the environmental and community health dimensions, this study extends into other domains such as knowledge and capacity building, cultural identity, politics, and crime (to name a few). Whereas many studies are purely descriptive, this one relies on a research design also intently focused on policy as well as research gaps. The result is a hopefully synthetic, complex but more complete paper than one that could have been written by focusing only on one or two of these dimensions in isolation.

However, as the study will also reveal, the narrative of degradation and despair is incomplete, and fails to capture some of the benefits e-waste has brought Ghana including greater access to electronic and digital devices, skills and training, relatively high paying jobs, and even pride and resilience within scrapyards communities. The study reveals both the peril and promise of e-waste in Ghana, and in doing so it helps counter overly dire narratives focused only on what Akese and Little (2018) frame a “a landscape of violence and toxicity.” Furthermore, Agbogbloshie offers a fascinating case study of where informal e-waste recycling in Ghana is a product of interlinked processes of local and global scales (Amuzu 2018). The study consequently offers an array of policy suggestions focused across these local, national, and global scales.

The paper proceeds as follows. It first defines e-waste and summarizes its qualitative research methods. Then, it offers a brief background of the contours and drivers of Ghana’s e-waste industry, before highlighting the benefits and risks to e-waste. The paper moves next to a discussion of policy recommendations and the penultimate section discusses future research directions, before offering five core conclusions. Rather than using a standard structure—of “Results” or “Discussion”—it instead relies on a more inductive, thematic, and

¹ As Puckett (2011: 44) has astutely written: “Wherever we live, we must realize that when we sweep things out of our lives and throw them away... they don't ever disappear, as we might like to believe. We must know that ‘away’ is in fact a place... likely to be somewhere where people are impoverished, disenfranchised, powerless and too desperate to be able to resist the poison for the realities of their poverty. ‘Away’ is likely to be a place where people and environments will suffer for our carelessness, our ignorance or indifference.”

hopefully compelling structure grounded in the data itself, organized around the core themes of the paper, namely background and drivers, benefits, risks, policies, and gaps. The idea here is to “do the work for the reader” to tell them what the most important or novel themes arising out of the data are, rather than forcing them to decipher it themselves.

2. E-waste, case study selection and research methods

To begin, it is perhaps helpful to define what e-waste is before we introduce readers to the Ghanaian case study site of Agbogbloshie (and Accra) and discuss the mixed methods utilized in the study.

2.1 Defining electronic waste (e-waste)

E-waste is broadly defined as “all types of electrical and electronic equipment and its parts that have been discarded by the owner as waste without intention of re-use” (Kumar et al. 2017: 33).² Amankwaa et al. (2017) add that many times e-waste flows contain not only intact electronic products, but also broken wires, plastic shards, glass, and parts—which can enter a variety of possible management streams including reuse, reselling, salvage, or disposal.

2.2 Site selection of Ghana and Agbogbloshie

Ghana and Agbogbloshie were selected for analysis because of their high-volumes of e-waste. Ghana is one of the top four African countries that imports e-waste each year, coming after Nigeria, South Africa, and Morocco (Schluep 2012). Within Ghana, most e-waste ends up at Agbogbloshie, a community neighborhood and scrapyard, formerly a wetland, within the Greater Accra Metropolitan Area. Agbogbloshie is located close to the Gulf of Guinea but also the Central Business District of Accra, which is only one kilometer away. Even though it is relatively small—less than a square mile in total size—is the veritable “main hub” in the country for e-waste, being home to at least 40,000 inhabitants living and working around the scrapyard (Akortia et al. 2017). Located on the banks of the

² More extensive definitions and classifications focus on six categories of e-waste (Baldé et al. 2017): (1) Temperature exchange or cooling and freezing equipment such as refrigerators, freezers, air conditioners, and heat pumps; (2) screens or monitors including televisions, laptops, notebooks, and tablets; (3) lighting including fluorescent lamps, high intensity discharge lamps, and LED lamps; (4) large electronic equipment or household appliances such as washing machines, clothes dryers, dishwashers, electric stoves, large printing machines, copying equipment, and solar photovoltaic panels; (5) small electronic equipment or household appliances such as vacuum cleaners, microwaves, ventilation equipment, toasters, electric kettles, electric shavers, scales, calculators, radio sets, video cameras, electrical and electronic toys, small electrical and electronic tools, small medical devices, and small monitoring and control instruments; and (6) small information technology and telecommunication equipment such as mobile phones, Global Positioning Systems (GPS), pocket calculators, routers, personal computers, printers, and telephones.

Odaw River and in the upper reaches of the Korle Lagoon, Agbogbloshie began as a market for vegetables and fruits before expanding into a “slum” and then a scrapyard dealing with waste and recycling on a large scale (Akortia et al. 2017). Agbogbloshie is also unique in its proximity to local communities and the cohabitation of the scrapyard alongside a yam market, tomato market, onion market, football pitch, and mosque. Yet, as confirmed when visited, the site is nonetheless littered with scrap metal, engine parts, plastic and glass shards, computer parts, circuit boards, and tangled wires. Admittedly, Agbogbloshie is not just a scrapyard – Agbogbloshie covers a broader collection of spaces, referring to an urban area in Ghana’s capital Accra, a vegetable market, a scrap metal yard, a large slum, an industrial area, and a household waste dump shown in Figure 2.

Figure 2: The Agbogbloshie scrapyard and greater community in Accra, Ghana, 2019

Source: Oteng-Ababio and van der Velden (2019). As the map indicates, the Agbogbloshie neighborhood includes not only the metal scrapyard but also a household waste dump, multiple markets, and Old Fadama, the former slum that existed onsite before the scrapyard industry began to expand.

2.3 Mixed-methods research design

To collect data on Agbogbloshie, this study relies on a mixed methods research design involving expert interviews, community interviews, naturalistic observation and site visits, and a literature review.

The author first conducted semi-structured expert research interviews in January and February 2019 at a variety of institutions involved with e-waste in Ghana. These experts were selected based on their knowledge and familiarity with either e-waste in Ghana or global e-waste policy. The targeting sample for respondents included:

- Government agencies such as the Environment Protection Agency (EPA) and the Ministry of Environment, Science, Technology and Innovation (MESTI);
- Civil society groups such as Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), the World Resources Forum, and Green Advocacy;
- Private sector firms and organizations including the Greater Accra Scrap Dealers Association (GASDA), Scrap Dealers Association at Agbogbloshie as well as local electronics shops and firms;
- Academic institutions, including the Department of Geography and Resource Development, Institute for African Studies, Institute for Environment and Sanitation Studies, and the School of Public Health at the University of Ghana

During each interview, the author asked the following standard questions: “What positive benefits and negative costs associated with e-waste did you witness with the community?” “Who has been the most vulnerable, or significantly impacted?” “What community responses have taken place?” “What policies need implemented?” “What do you see the future as being like for affected communities?”

Each interview lasted generally between 45 and 120 minutes, and respondents were guaranteed full anonymity to encourage candor and protect respondents from potential retaliation. As Table A1 in the Appendix shows, eleven interviews were conducted and each participant was given a unique respondent number, referred to throughout the rest of the paper as “Expert Respondent” 1 to 11.

Given the research questions focused intently on community perceptions and impacts, expert interviews were coupled with actual community interviews around Agbogbloshie, where the author met with e-waste workers, attended community meetings, and talked to families living there or working at the market. In total, 21 of these community interviews were conducted, following the same questions or script as the expert interviews, although usually shorter in duration. The average community interview lasted between 15 and 45 minutes. Each respondent was guaranteed anonymity, and also assigned a unique respondent number (“Community Respondent” 1 to 21) shown in Table A2 of the Appendix.

To complement the interviews, the author also conducted 20 site visits—including three separate visits to the Agbogbloshie scrapyard and neighborhood—so that naturalistic observation could be undertaken (see Table A3 in the Appendix). Naturalistic observation, or unstructured observation, involves what McLeod (2015) calls “studying the spontaneous behavior of participants in natural surroundings,” with the researcher recording what they see. This helps supplement structured or controlled methods in that it enables examining behavior or events in the real world—much like the difference between viewing wild animals in a zoo, or their natural habitat. Margaret Mead most famously used the method of naturalistic observation to study tribal communities in the South Pacific, and Kathy Sylva used it to study the behavior of children at play in Oxfordshire. Key strengths of the method include greater validity, with highly realistic and authentic accounts being produced that can capture spontaneous events or reactions; little to no interviewer influence or biases of social desirability; and the opportunity to study a situation in its total context and complexity (McLeod 2015). Weaknesses include the lack of a representative sample, the reliance on a small (micro) scale, and inability to replicate findings (McLeod 2015). Hence the utility of mixing naturalistic observation with the other two methods in the study of expert and community interviews. Each of these naturalistic site visits lasted between 20 and 200 minutes.

To further triangulate our data from the interviews and site visits, and also to better position it within the body of growing research, we lastly conducted an interdisciplinary literature review of studies looking at electronic waste and Ghana, especially Agbogbloshie, published within the past ten years (i.e., from 2010 to 2019). The Scopus and Science Direct databases were searched for terms such as “e-waste,” “electronic waste,” and “electrical waste” as well as phrases such as “Africa,” “Ghana,” and “Agbogbloshie.” The resulting

corpus of approximately thirty studies is cited throughout this study to help situate or confirm our findings within the literature.

Finally, the study presents a fairly large number of photographs and images related to e-waste in Ghana, collected during the fieldwork. This is because such images act as important “physical evidence” that can “develop a more precise understanding” of the topic being studied (Yin 2003: 96). Methodological scholar Pink (2007) has argued that photographs can uncover a sort of “visual ethnography” that reveals the meaning behind events in ways that words cannot. Birdsell and Groarke (1996) also tell us that because we experience our world through both words and images, the exclusion of “visual elements” from the argumentation process artificially narrows the research process. As Prosser and Schwartz (1998: 116) have written:

[Photographs] can show characteristic attributes of people, objects, and events that often elude even the most skilled wordsmiths. Through our use of photographs we can discover and demonstrate relationships that may be subtle or easily overlooked. We can communicate the feeling or suggest the emotion imparted by activities, environments, and interactions. And we can provide a degree of tangible detail, a sense of being there and a way of knowing that may not readily translate into other symbolic modes of communication.

Though the practice of including images in research is more common in the disciplines of advertising, business, marketing, anthropology, sociology, communication studies, and rhetoric, the images presented below are intended to meet precisely these goals.

3. Background: Contours and drivers of Ghana’s electronic waste “crisis”

This section of the study briefly overviews available data on waste and e-waste streams in Ghana before discussing some of the drivers behind this e-waste, such as rising incomes and materialism, short product lifetimes, and cultural norms.

3.1 Quantifying e-waste flows in Ghana and at Agbogbloshie

Although data is difficult to verify, given the complexity of waste flows as well as the presence of clandestine and illegal channels, approximately 215,000 metric tons of electronic and electrical products are imported into Ghana, with as much as 15% being classified as waste at the time of importation (Amankwaa 2017). Baldé et al. (2017) estimate that Ghana

also generated 39,000 metric tons of domestic e-waste inside the country. As Expert Respondent 4 also reflected on this point:

E-waste is the fastest growing component of the global sanitation and waste industry. Electronic waste keeps evolving, iPhone 5, iPhone 6, iSomething, the revolution is so rapid, and it has resulted in mountains of e-waste here in Ghana.

Expert Respondent 1 added that Ghana has seen a recent “flood or mass inflow of electronics and waste.” Expert Respondent 3 that “Ghana is unique in its magnitude of electronic imports.” Business Ghana (2018) estimated that e-waste was a \$100 million annual business within the country.

The bulk of this waste ends up at Agbogbloshie. Expert Respondent 1 projected that within Agbogbloshie, “my guess is at least one-third of all the waste at the scrapyards is e-waste, the rest is metal waste, plastic waste, solid waste or scraps.” Within this waste, scrapyards workers often search for valuable metals such as gold, copper, and palladium (responsible for three-quarters of e-waste revenues around the world), although they collect other metals and materials ranging from aluminum and tin to platinum and cobalt (see Table 1).

Table 1: Top ten lucrative metals or materials within global e-waste streams

Rank	Metal or material	% Revenues
1	Gold	50.4
2	Copper	13.9
3	Palladium	9.5
4	Plastics	9.2
5	Silver	3.6
6	Aluminum	2.5
7	Tin	2.0
8	Barium	1.8
9	Platinum	1.7
10	Cobalt	1.6

Source: Cucchiella et al. 2015.

3.2 Materialism, culture, and the drivers of e-waste flows

The drivers behind expanding e-waste flows are complicated, but hinge upon at least four separate factors identified by our material. These include rising incomes and a focus on materialism and electronics goods; the rise of cheap Chinese imports with short product lifetimes; cultural norms about modernity but also receipts of e-waste from expatriates abroad; and an increase in illegal and undocumented waste flows.

First, the share of domestic e-waste generated within Ghana has grown as many households have increased the incomes they earn and aspire to purchase electronic and digital devices. This includes trends in digital currency and mobile money (which require smart phones or at least phones with connections to the internet) as well as the aspirations of students and the middle class. Figure 3 for instance shows a Ghanaian checking his phone underneath a sign for phones at the Accra Mall (top panel), advertisements for phones at the University of Ghana (middle panel), and a mobile money stall near the Central Business District in Accra (bottom panel). As Expert Respondent 3 explained:

The modernization of Ghana and expansion of the middle class is certainly driving increases in e-waste. If you walk along the streets of Accra, in every area you will find someone emptying a container, full of shoes, clothing, car parts, radios, televisions, phones, and electronics. The demand and desire for quality used e-products is insatiable, and growing. More and more people really want new electronic products, and they believe in the potential for how these digital things transpire to make life better.

In its own way, this is a partially positive sign that Ghana is no longer serving merely as a “dump” for rich, developed countries of the North, and instead reflects shifting patterns in e-waste as the local population comes to adopt more digital devices (Lepawsky 2015). Expert Respondent 2 added that “*E-waste has only been worsened by government policies, especially those promoting new household devices.*”

Figure 3: The rise of mobile telephony, the internet, and digital currency in Ghana

a. Accra Mall, Accra, February 2019

b. Central business district, Accra, February 2019

Source: Author. Advertisements throughout Accra promote new digital technologies such as Samsung or Apple smart phones as well as subscription plans to the internet. Such phones can be used to pay with “mobile money” at many shops throughout the region—creating a strong social norm towards the adoption and ownership of these new technologies.

Second, coupled with rising incomes and aspirations has been a notable increase in the importation of cheap electronics products, particularly from China, known for extremely short product lifetimes. Expert Respondent 3 explained that:

An additional problem is certainly the bad quality of electronic goods with short lifetimes from China. Most of the imported electronics in Ghana are energy guzzling hogs that would never be marketed in Europe or North America. They are extremely inefficient and many breakdown within the first year of operation.

Expert Respondent 4 added that the liberalization of the Ghanaian economy has pushed economic activity in this direction as well, as it has enveloped “*the growth of Ghanaian transnational traders, who travel to China to bring white goods for sale back to Africa.*” Nonetheless, despite their planned obsolescence and lack of perceived reliability, many Ghanaians still make purchasing decisions only on the capital cost of the product. This can create pressures for a high consumption society geared more towards disposable products. As Community Respondent 11 put it, “*I have no interest in repairing, reducing, or reusing when I can get new technology for cheap. Anything broken or in need of repair, I throw into the bush.*”

Third, cultural norms about prestige, patronage, and permanence all further create momentum towards greater numbers of electronic goods and resulting waste. In terms of prestige, Expert Respondent 4 explained that “*due in part to the lack of reliability over Chinese products, there is an emerging stigma against them that works in favor of technology from Europe or the United States—people view it as prestigious to have a second or even third hand device instead of a new device from Asia.*” In terms of patronage, multiple respondents discussed how when Ghanaians live abroad, they will often stockpile goods from where they reside—in Canada, France, Norway, and so on—and then purchase shipping containers to send them back home. Expert Respondent 3 put this in the context of Ghana being import dependent already for many goods:

We can look at the e-waste issue more generally from a perspective from Ghana being import dependent, we really import everything from fish to cars to computers and clothing. Ghana domestically produces little. Because of that, you have this large diaspora in Asia, Europe, and North America who engage in what I call processes of informal exports, and bring things into Ghana. Every year, for example, I know of many friends who will fill shipping containers full of used household items—

especially computers, phones, and household appliances—and ship them directly to Accra.

Expert Respondent 11 affirmed this practice, noting that “*when I lived abroad, every year some friends and I would pool our resources and fill a shipping container with used sofas, household items, phones, and commutators, and send it to Ghana.*” They went on to affirm that many times broken goods were included so that they could be repaired and then sold at “*significant profit*” back in Africa. Daum et al. (2017) warn that this process also results in the underreporting of waste flows, given that typically they are undisclosed or falsely labeled as “charitable donations” or “donations.” In terms of permanence, Expert Respondent 9 explained how many Ghanaians keep old electronics around “just in case.” As they expanded:

Ghanaians accumulate an enormous amount of e-waste. They have this “just in case mentality” where they stockpile volumes of old electronics, even broken ones. I look around my office and I see a non-functioning printer, two phones, a broken digital scanner, an extra keyboard, and an old desktop computer. Why do I keep these? Just in case.

All three aspects—symbols of prestige, feelings of patronage, and a desire to keep things around “just in case”—contribute to burgeoning volumes of e-waste.

Fourth and lastly, we have the issue of illegal movements of waste and undocumented transshipments. Hickey (2018) emphasizes that global estimates of e-waste (and national estimates in Ghana) are likely conservative, as much is undocumented or processed through incorrect disposal channels. They noted that just a fifth of the 45 million metric tons of equipment produced annually is properly tracked for collection and recycling, according to the UN, while the fate of the rest is unknown and likely to end up in areas such as Agbogbloshie.

3.3 An emerging environmental health crisis?

Consequently, the volume of e-waste in Ghana has grown considerably over the past decade. However, crude and dangerous processing and dismantling efforts aggravate the spread of toxins within e-waste, via the burning of cables (to collect copper) or the burning of residues to reduce the volume of waste (Amankwaa 2014). Expert Respondent 4 added that “*E-waste is hazardous in nature, chemicals are very dangerous, not just metals; what makes it more dangerous is the after-products of combustion, which become far more toxic than the elemental forms in the e-waste. The fact that they burn it and melt it amplifies the risk.*”

Thus, as Prof. Frimpong-Boateng, the head of the Ghanaian EPA, put it “electronic waste has emerged as one of the most serious environmental challenges in Ghana and the world today” (quoted in Business Ghana 2018: 2).

4. Highlighting the ostensible benefits of e-waste in Ghana

Notwithstanding such crisis rhetoric, our material strongly emphasized that e-waste is not only a burden in Ghana, but entails multiple benefits. Despite its often-recognized risks, e-waste has brought a collection of meaningful benefits to the workers and families of Agbogbloshie, Accra, Ghana as a whole, and beyond. Expert Respondent 1 acknowledges that Agbogbloshie is a vital part of the local economy across multiple dimensions:

It is a hub of entrepreneurial activity. Agbogbloshie has created a niche that satisfies Ghana's economic metabolism. The community has cleverly situated themselves into the value chain, from scavengers and collectors, to the purchasers and dealers, those who sort and segregate, then those who repair and refurbish. On top of that, you have the main scrap dealers buy waste in bulk, looking for rare or precious metals. Then there are the firms that export scrap or used electronic products out of Ghana. Furthermore, you have an array of non-e-waste activities that support the process: people repairing, selling screwdrivers and tools, renting out carts for hauling waste, food stalls, water providers, those who manage hotels (makeshift shacks and beds), and drivers of trucks for hauling, fuel provision, even security services for the transfer of particularly valuable materials such as copper, palladium, and gold. It is its own vitally important economy.

Expert Respondent 4 agreed and noted that:

The benefits of e-waste are clear: it brings one of the poorest populations in Ghana immediate economic dividends. It addresses unemployment for the low skilled and less educated population, who have remained chronically poor and are neglected by government policy. They would never survive in the formal economy, so for them going into the e-waste trade makes a great deal of sense: it is non capital intensive, it does not require much training or knowledge, and it consists mainly of walking around and collecting discarded materials. If you work hard, you can do well.

This section inductively organized these benefits, moving from local scales at the site to larger scales such as Accra or all of Ghana and even West Africa. These benefits include (1)

urban employment and high paying jobs, (2) skills training and capacity building, (3) relief and protection for ethnically vulnerable groups, (4) community identity and pride, (5) efficient waste collection across Accra, (6) obviating the need for decentralized waste facilities across the country, (7) ancillary economic growth through repair shops and secondhand markets, (8) widening access to electronic products, (9) national remittances which act as a lifeline to many in poverty, and (10) creating regional and even global re-export and commodity flows.

4.1 Urban employment and high paying jobs

The first and perhaps most direct benefit of e-waste is that it does provide urban employment and comparatively high paying jobs. Amuzu (2018) as well as Grant and Oteng-Ababio (2012) note the *range* of jobs provided, from collectors (or “scavengers”), dismantlers and burners to middlemen, scrap dealers, and managers (or what Expert Respondent 10 called “*bosses*”). Amankwaa (2014) underscores that many of these scrapyard jobs are suitable for young adults, especially those such as collecting or burning that do not need advanced skills.

For instance, in our own community and expert interviews, financial motivations for participating in scrapyard activity came up repeatedly. Community Respondent 2, a scrap collector, stated “*The days are long, I push this cart for maybe 12 to 15 hours, but the pay is good. I get paid more than twice what I made at a bakery, and three times what I made washing dishes.*” Community Respondent 5, a repairer, remarked “*I love what I do and will do it until the day I die.*” Community Respondent 6, another repairer, mentioned that “*electronic waste and repairing is the best thing to happen to me and my family.*” Community Respondent 7, a middleman, noted that “*e-waste is my livelihood, my life, my family depends on it.*” Figure 4 shows collectors operating around Accra.

Figure 4: A scrapyard “scavenger” collecting electronic waste in the Airport District, Accra, 2019

Source: Author, with permission granted by each “scavenger,” or collector, to be photographed. The collectors work on average 8 to 12 hours a day and are paid wages based only on what they successfully harvest.

Statements about the value and quality of the work being done at Agbogbloshie have been confirmed in earlier research. Grant and Oteng-Ababio (2012) calculated at the time of their study that the average e-waste collector or daily wage laborer earned about \$3.50/day, about two and a half times above the average income of informal economic workers in Ghana. Daum et al. (2017) offer a more detailed breakdown of estimated average monthly incomes associated with e-waste in Ghana in Table 2, and the percent this is above the daily minimum wage. These exceptionally high wages, especially for scrap dealers and middlemen, likely explain why the turnover rate of unemployment at Agbogbloshie is low—every three to seven years—and that as a result “rewarding financial compensation trumps most feelings of self-pity especially” (Daum et al. 2017: 5).

Table 2: E-waste labor segments in Agbogbloshie, Ghana

Role in E-Waste Circuitry	Estimated Average Monthly Income (USD)	Percent of Ghanaian Daily Minimum Wage	Main E-Waste Activities
<i>Global Firm</i>	N/A	N/A	Global recycling company that imports raw and processed scraps from abroad and from within Ghana. Performs more sophisticated refining of materials and exports products to global clients.
<i>International Firm</i>	\$20,000+	N/A	Formal recycling export firm located in export processing zone in Tema. Buys from scrap dealers and finances own scrap collectors.
<i>Scrap Dealer</i>	\$1500	2747%	Commands e-waste operations at the top of the e-waste trade hierarchy; negotiates deals with players in the formal economy.
<i>Middleman</i>	\$1050	1923%	Acts as an intermediary between scrap dealers and recyclers. Well-connected individuals who prepare recycled scraps for resale.
<i>Refurbisher</i>	\$190–\$250	348%–458%	Repairs non-functioning electronic goods to be sold in the Ghanaian secondhand electronics market.
<i>Recycler</i>	\$175–\$285	321%–522%	Picks through e-waste in order to extract metals. Individuals may or may not choose to specialize in a particular type of electronic. Many recyclers partake in open burning as an extraction technique.
<i>Scrap Collector</i>	\$70–\$140	128%–256%	Collects obsolete electronics in carts or rentable cars-for-hire. Collectors either buy e-waste from consumers or scavenge for parts at dump sites.
<i>Child Laborer</i>	≤\$20	≤36.6%	Males participate in recycling or collecting. Young girls may be found distributing water for consumption and fire control.

Source: Modified from Daum et al. 2017.

4.2 Skills, learning and training

A second benefit, closely related to the actual income that scrapyards employment brings, is the development of skills. As Expert Respondent 9 put it:

Do not underestimate the skills and knowledge Agboglobloshie creates. People learn about refurbishments and clever use of parts to repair new ones. I have even seen their repair people tackle technically difficult jobs at a fraction of the cost of more professional ventures (like the Apple store). Agboglobloshie is truly building a strong base of technical expertise.

Thus, this benefit extends beyond mere financial remuneration as it encompasses the things that workers learn during their tenure at Agboglobloshie.

4.3 Relief and protection for vulnerable migrants

Agboglobloshie offers a safe haven for migrants, usually from the North and often poor, Muslim, and landless, who would otherwise remain vulnerable within Ghanaian society.

Expert Respondent 1 remarked that “Agboglobloshie creates a protective space for migrants in the North of Ghana that otherwise have no access to jobs.” Expert Respondent 4 said that “e-

waste workers are often migrants fleeing criminal or ethnic violence in the north, so they lack any formal connections here to get any other sort of job. These are humanitarian refugees seeking greener pastures, coming to Accra to make a brighter future.” Amuzu (2018) affirmed this finding as well, noting that many of the informal e-waste workers were migrants from the North escaping drought, conflict, and unproductive farming activities.

4.4 Community identity and dignity

A more profuse and difficult to discern, but nonetheless real, benefit relates to community identity. Expert Respondent 7 stated that *“there is a sense of dignity around the work at Agbogbloshie, people are proud to be scrap collectors and dealers.”* Expert Respondent 11 added that *“We cannot just tell them not to do this kind of work. They need it, it sustains them. It supports thousands of people, it is their identity and way of life.”* Indeed, this sense of pride and accomplishment was evident during the author’s own site visits—upon each visit, many workers would gladly stop their activities to pose for photos, including the dealer in Figure 5.

Figure 5: A scrapyard dealer posing with copper wire at Agbogbloshie, 2019

Source: Author, with permission granted by the dealer to be photographed. This particular dealer was very friendly and posed for no less than a dozen photographs.

For reasons such as these, Expert Respondent 7 clarified that most local Ghanaians prefer not to even use the word “waste.” As Expert Respondent 7 stated:

We call it e-waste, but people on the ground do not call it that ... Scrap dealers do not identify as waste managers, they instead see themselves as harvesting commodities as part of a lively value chain. They are community stewards.

Oteng-Ababio and Grant (2019) found this to be true in their own research on Agbogbloshie, noting that it created a sense of belonging and was viewed as a source of “life-saving” and

“empowering” jobs. Some inhabitants even referred to it as “New York City, a land of freedom to pursue opportunity” in Ghana.

4.5 Efficient scrap collection and a cleaner Accra

An additional benefit to the e-waste scrapyards is efficient collection of waste across the entire city (and indeed, even into the surrounding countryside). As Expert Respondent 4 noted, “*scavengers help city authorities who would otherwise be spending money collecting waste.*” Expert Respondent 7 agreed that the e-waste collectors provide “*an environmental service*” and that “*their processes are fantastic: collection rates are close to 100% across Accra, which is very good and keeps the streets clean. In addition, they offer manual dismantling of non-hazardous e-waste, cleansing the city.*” Expert Respondent 9 mentioned some of the public health benefits such scrap collection yields:

Before Agbogbloshie, people simply discarded e-waste in the cover of darkness in their own neighborhoods. Many household items are bulky, they cannot go into your trash, and cannot be put in storage, so people would simply chuck these things into the bushes, into the ocean, into sewers. That had a serious implication for community health. Every neighborhood became a receptacle for toxic pollution, but also water that bred mosquitos. All these scattered devices collected water that became stagnant, further leading to outbreaks of malaria.

Expert Respondent 9 even estimated that the informal collectors for waste and e-waste have saved Accra \$181 million dollars in avoided collection fees and pollution, noting “*these collectors in the informal sector pick it for free at no cost to local government.*” Expert Respondent 11 added that “*everyone in Accra sees and values the work that the scrap collectors do, they clear out all of these broken down cars and trucks, they purify the city of scrap and waste.*” Schluep (2012) confirmed this benefit in their own research, noting that waste collection rates in Ghana are some of the highest in the world, at up to 95%.

4.6 Economies of scale at a centralized facility

In tandem with improved collection rates, our evidence also identified the merits of having a centralized e-waste facility such as Agbogbloshie rather than a series of more fragmented, less controlled waste sites spread across the country. Expert Respondent 7 argued that “*a centralized facility in Accra like Agbogbloshie makes a great deal of sense, it is far better than disposing electronic equipment into latrines, or open pits.*” Expert Respondent 9 also admitted a centralized facility avoids “*mountains of trash in certain areas,*

piles of rubbish.” This means Agbogbloshie provides “*centralization and economies of scale*”. As Expert Respondent 9 continued: “*It’s far better to have waste and e-waste at Agbogbloshie than in separate sites spread across Accra that are not as good, that do not have the necessary expertise in servicing, waste collection, repair, and recycling. The standards of practice at Agbogbloshie are far superior to these other scattered sites, which would only widen the environmental crisis.*” Minter (2016) supported this finding in their research, noting in interviews with scrap dealers that they perceived they were doing something “good for the environment.”

4.7 Expanding access to electronic products

A broader benefit to Agbogbloshie (and e-waste trends in general) is that they help Ghana bridge the digital divide and spread electronics goods throughout society. Expert Respondent 1 explained that “*the biggest benefits of e-waste have been to bring digital devices and modern technology to Ghana that would not otherwise be here ... giving people of low-income access to affordable electronic devices.*” Expert Respondent 3 suggested that those in Ghana may put such electronic devices to *better* use than consumers in Europe or the West, arguing that “*the poor are the best users of everything, far more sustainable than Western lifestyles. The poor will use, reuse, and continue to use products until they are really and irrevocably dead ... We can also repair and fix, things will last forever here, we fix it, fix it, and fix it.*” Expert Respondent 9 concurred, and noted that the flows of e-waste into Ghana can be viewed as a way of more “*equitably and justly distributing electronic devices to Africa*” and that Agbogbloshie in a way can be interpreted as a process of “*technology transfer.*” Amankwaa et al. (2017: 1570) agree and wrote that “importing used products means that electronics are now affordable to a wider population.”

4.8 Positive synergies with the electronics resale industry

Closely connected with expanding access to e-devices is the promotion and sustenance of an electronics industry in Ghana. Expert Respondent 7 articulated that “*the services at Agbogbloshie are strongly interlinked with repair and electronics shops, creating economic value for other parts of the retail supply chain.*” Indeed, during the site visits, the author saw firsthand the sheer diversity and quantity of used electronics goods available (even on roadsides, see top panel of Figure 6) as well as constant repairing (see bottom panel of Figure 6). For reasons such as these, Expert Respondent 9 affirms that “*Agbogbloshie is the cornerstone of a huge secondhand market in the country for e-goods ... electronic waste to them means electronic fortune.*”

Figure 6: Repair electronics shops and repairing practices in Ghana, 2019

a. Repaired electrical goods for sale near Sege, Ghana

b. Practices of microwave repair in Accra, Ghana

Source: Author, with permission granted by each worker to be photographed. Literally hundreds of electronics and repair shops have proliferated across Accra and Ghana as a whole in the past decade, both expanding access to secondhand electronics products and also increasing the lifetimes of those products.

4.9 National remittances and a lifeline out of poverty

An additional broader benefit to e-waste and Agbogbloshie is the revenue it generates via remittances back to other parts of Ghana to lift people out of poverty. Amuzu (2018) noted in their evaluation of Agbogbloshie that many in the workforce remit some or even most of their returns to relatives outside of Accra. Daum et al. (2017) estimate that as a whole, Ghana's e-waste activities produce as much as \$268 million in annual revenues that sustain at least 200,000 people across the nation. Expert Respondent 11 also stated this number, noting that the e-waste economy, if you consider the fuller scope of repair shops, export firms, scrapyard dealers, and the people who buy raw materials in Tema, can count "*as many as 200,000 people over the country are beneficiaries.*" Daum et al. (2017) suggest that only up to 8500 of these people are actually working at the site, many of the rest are arguably benefiting from these remittances.

4.10 Regional and global commodity flows from China to Nigeria

A final benefit from e-waste, operating at the largest scale, relates to the circulation of e-waste products back into the global economy. Grant and Oteng-Ababio (2012) note that circuit boards are often ground into a fine powder and copper and shipped directly to China and India. Expert Respondent 9 articulated this aspect when they said:

Multi-scalar networks of knowledge and patronage have emerged to profit from e-waste flows. Nigerians for instance knew gold was in motherboards, so they convinced all of the collectors into selling them motherboards for a good price, albeit far less than the gold was worth. Nigerians even learned to pre-finance trips outside of Accra, sending expeditions of boys to search for motherboards in areas across the country, paying for food and travel as long as they brought the motherboards back. Chinese traders have also come in, adopting the Nigerian model, putting money to containers and scales. They will collect valuable materials—copper, cobalt, gold—and then ship them immediately to China.

Expert Respondent 2 and Expert Respondent 6 also suggested that many of the second or third hand repaired products were also leaving Ghana to head to markets (and the urban poor who demanded the products) in Benin, Nigeria, and Togo.

5. Revealing the mounting risks of e-waste in Ghana

The benefits of e-waste, of course, do not exist in a vacuum. The data collected also reveal a sobering collection of ten risks. These are (1) environmental degradation, (2) worker vulnerability and occupational health, (3) child labor, (4) women and maternal health, (5) ethnic exclusion and violence, (6) hazards and fires, (7) theft and disruption to basic infrastructure, (8) contamination of food across Accra, (9) politicization, powerlessness and lack of policy enforcement, and (10) hacking and cybersecurity.

5.1 Environmental degradation within Agbogbloshie

The clearest and most direct impact from e-waste is a persistent and long-lived threat to the environment. Expert Respondent 9 reflected that “*You can always smell Agbogbloshie before you get there, and many people’s first impression is that you have entered Sodom, a burning, smoking, hell.*” Given that Agbogbloshie sits on a former wetland, the scope of environmental degradation is not difficult to contemplate. Frazzoli et al. (2010) emphasize the multiple discharge points that hazardous substances from e-waste can enter the environment, with Figure 7 showing liquid releases to rivers, contamination of soils,

atmospheric pollution via fires and dust, and even exposure to the sea and shoreline as well as uptake by animals. Tue et al. (2016) looked at only one piece of this puzzle, soil exposure, and found that the median total toxic equivalent concentration in open burning soils was 7 times higher than health action levels in the United States. Daum et al. (2017) identified air samples from the Agbogbloshie market with heavy metals and polychlorinated naphthalene congeners, as well as high concentrations of copper, cadmium, lead, iron, chromium, and nickel in marine environments including Accra's Korle Lagoon, Odaw River, and coastal waters.

Figure 7: The multiple pathways of potential environmental degradation at Agbogbloshie

Source: Frazzoli et al. (2010). Electronic waste gives rise to multiple possible pathways of environmental exposure, including pollution of the air, water, land and soil, and climate.

Some recent policies have only served to aggravate the extent of degradation and pollution. Atiemo et al. (2016) note that the Accra Metropolitan Assembly (AMA) added waste streams to the site, seeking to both capture revenue from informal activities and also

further centralize waste streams. This transformed the area northwest of the scrapyard into a “transfer station” for trucks wanting to discard solid waste and glass. These trucks now pay a fee to the AMA, and then dump unsorted solid waste into the ground without proper protection (such as lining) or environmental monitoring.

5.2 Worker vulnerability and occupational health

Given the degradation of the environment, multiple respondents discussed how the scrapyard workers themselves are the most vulnerable community impacted by e-waste, despite the fact that they benefit financially from it. Perkins et al. (2014) conducted a broad global review of the health consequences of e-waste exposure and warned that it includes changes in lung function, thyroid function, hormone expression, cognitive development, cytotoxicity, and genotoxicity. In Ghana more specifically, Expert Respondent 1 noted that *“the workers themselves are extremely vulnerable, they are surrounded by open dumping but lack the basic amenities such as electricity or sanitation to make it safe.”* Expert Respondent 3 added that *“occupational exposure to toxins is a huge health risk.”* Expert Respondent 7 stated that *“the range of environmental exposure pathways means that even collectors and scavengers who do not spend all of their time at the site get contaminated.”* Figure 8 for example shows a collector delivering a computer monitor to the Agbogbloshie scrapyard, exposing him to smoke.

Figure 8: A scrapyard “collector” or “scavenger” delivering a computer monitor to the Agbogbloshie scrapyard, 2019

Source: Author, with permission from the collector to be photographed. This particular collector works seven days a week to support their extended family in Tamale.

An array of robust research has emerged to confirm many of these health impacts facing e-waste workers and informal scrapyards employees. One of the first studies, sponsored by the Ghanaian Ministry of Health, documented that those engaged in recycling e-waste had unsafe levels of barium, bromium, magnesium, and selenium in their blood, and unsafe levels of lead in their urine (Caravanos et al. 2011). Moreover, many workers had fungal rashes and elevated blood pressure. Asante (2012) confirmed the presence of elevated levels of heavy metals such as iron, antimony, and lead in the urine of e-waste workers. Feldt et al. (2014) confirmed higher urinary levels of polycyclic aromatic hydrocarbons and also documented that two-thirds of e-waste workers complained about persistent coughs and one-quarter frequent chest pains. Daum et al. (2017) undertook a systematic review of the health evidence and noted a consensus in the literature that the blood samples of e-waste workers show elevated levels of multiple metals. Hickey (2018) argues that as a result, e-waste workers suffer from debilitating health effects and that many workers contract cancer in their 20s.

5.3 Child labor and infant health

The environmental hazards from e-waste are not limited to workers. There are plentiful children at the site, some directly collecting waste and working, some indirectly supporting the waste workers by selling food or providing services, and still others who merely reside there within the site. Expert Respondent 1 confided that he has even seen “*children delivering waste to the site on tricycles and scooters,*” and Expert Respondent 7 added that “*you always see unaccompanied children.*” Expert Respondent 11 explained further that:

The issue of child labor at the site is real as well as tricky. Some tribes still practice polygamy in the North which means oftentimes you have a 70 year old man with a 7 year old son. When the old man dies, the boy becomes the “man of the house” and all of the family’s obligations are passed to him. What is he to do? He has no job, he must care for his family, so he seeks the best opportunity he can which is working at Agbogbloshie in Accra, by far the option that pays the most for unskilled work. Child labor laws are not enforced, minimum wage laws are not enforced, but in this situation that is almost a blessing so that the family can survive.

Depressingly enough, there is even a football pitch inside the scrapyard and little boys and girls are known to work alongside collectors and burners. During the author’s own visit to the site, multiple children were observed including this some walking barefoot and delivering circuit boards to collectors.

The elevated risk of such children to health complications is severe. For example, Akortia et al. (2017) examined concentrations of polybrominated diphenyl ethers and other trace metals in soils, and estimated average daily doses for children that were a major “cause for concern,” especially for copper and lead. Grant et al. (2013) performed respiratory tests on boys aged 8 to 9 years old within the site and noted they had more trouble breathing, and also that boys aged 11 to 13 had high levels of blood chromium concentrations. Asante et al. (2012) warn that “children are much more sensitive to chemical hazard than adults,” placing them in a unique risk. The Ghana Health Service confirmed infants contract cancer as the result of breast milk from mothers at Agbogbloshie contaminated by metals; the resulting babies suffer with damaged central nervous systems, intellectual deficiencies, hyperactivity, cancers, lung disease and impaired cognitive functions (Ghana Health News 2019). Perkins et al. (2014) also found a correlation between exposure to e-waste metals and low birth

weight, complicated birth outcomes, abnormally slow childhood growth rates, and degradation of mental health.

5.4 Women and maternal health

Perhaps unsurprising given the risks to children, women are also particularly at risk environmental hazards throughout the site. In addition to sharing the same exposure as many of the occupational workers and children (see Figure 9), mothers within Agbogbloshie have been shown to have high level of PCBs (Asamoah et al. 2018). Many of the toxins on site can lead to endocrine disruption and neurotoxicity, leading Frazzoli et al. (2010: 388) to declare that Agbogbloshie was a “public health emergency, as it may entrain significant health risks also for generations to come.” Grant et al. (2013) reviewed studies on maternal health and e-waste towns, and showed that most studies suggest e-waste leads to increases in spontaneous abortions, stillbirths, and premature births. Daum et al. (2017) note a connection between e-waste exposure and declining neonatal health.

Figure 9: A woman selling water to e-waste burners and collectors at Agbogbloshie, 2019

Source: Author, with permission granted by the worker to be photographed. She sells food and water six days a week and lives in Agbogbloshie with her family and husband, who works as a collector within the scrapyard.

5.5 Ethnic exclusion and violence

An additional vulnerable group identified by our data was migratory workers and new entrants to the site, who are often given the worst jobs, and identified based on their religion or ethnicity. Expert Respondent 7 states that *“new e-waste workers are extremely vulnerable ... when they arrive, they are placed at the bottom of the scrapyard hierarchy and are given the most toxic jobs, such as burning.”* Expert Respondent 8 added that due to their tribal roots, conflicts between worker groups can occasionally spillover into violence, noting that *“there have been some violent conflicts at the scrapyard, due mainly to ethnicity, and whenever they change the leadership of the scrap yard, violent clashes have occurred between groups and with the police.”* Expert Respondent 9 confirmed that *“some of the migrants to Agbogbloshie do not leave their conflicts behind, they still cause fights with others.”* Indeed, Figure 10 shows a newcomer to Agbogbloshie (he had been there for less than a month) carrying out some of the most menial tasks. The author also saw the sleeping quarters for new workers, in one instance these were simply a collection of metal pipes people collapsed onto and a brick for an armrest or pillow.

Figure 10: A newly arrived migratory e-waste worker acting as a scavenger at Agbogbloshie, 2019

Source: Author, with permission granted by the collector to be photographed. This particular collector or scavenger spends the day lifting and carrying heavy household items to the site in temperatures often exceeding 100 degrees Fahrenheit.

5.6 Hazardous accidents and explosions

Moving up a spatial level beyond vulnerable groups, the community in and around Agbogbloshie was identified as being susceptible to heightened scope and severity of hazards, accidents, fires and explosions. Expert Respondent 4 explained that *“because it lacks environmental controls, the whole site is like living inside a poorly run factory, with all of the accident risks for fire and safety that entails.”* Expert Respondent 11 called it the proverbial *“ticking time-bomb.”* Atiemo (2016) reports that there was even a major explosion and fire at Agbogbloshie in June 2015 that claimed the lives of 159 people, with the blockage of drainage channels and illegal settlements blamed as strong factors in the severity of the event.

5.7 Theft and disruption to basic infrastructural services

Due to the fact that many residents in Accra and Agbogbloshie live in poverty, and that only a few have access to the higher paying jobs within the site, waste collectors and scavengers have been known to steal, destroy, and remove materials and electronic components throughout Ghana, at times disrupting services. Expert Respondent 1 said that *“scavengers do destroy electrical cables, take apart things and also have stolen wires and public property.”* Expert Respondent 3 had observed *“people extracting metal and wires*

from parked cars or traffic light systems,” Expert Respondent 9 stated that “when they are scavenging, collectors loot certain gardens and steal items which are not waste. They take aluminum street covers, they pillage traffic control boxes, they steal copper wiring, some climb and strip telephone wires, others climb electricity poles and steal the wires, which is also a safety risk because they can be electrocuted.” The author even witnessed some of this firsthand, with Community Respondent 3 admitting that “Today was a good day, the lock on this grate was broken so I was able to get about \$10 worth of cabling that I can take to the scrapyard.”

5.8 Contamination of foodstuffs across Ghana

Beyond the occasional fire and accident, or the theft of materials, perhaps an even more serious concern relates to elevated levels of pollution beyond Accra and even Ghana. This relates most acutely to food and has at least three exposure pathways: cooking pots, foodstuffs, and smoke.

One pathway exposure is through foodstuffs. Community Respondent 8 noted that within the Agbogbloshie site, *“they take polluted aluminum and make it into pots and pans for Accra.”* Community Respondent 4 explained that *“these kitchen pots are being made by melting down aluminum from rusty engines or roofing tiles, with hazardous pollutants inside, sort of like having a toxic Teflon that will leech pollutants for many years into soups and stews.”*

An additional exposure pathway relates to the various food markets and stalls at Agbogbloshie. Community Respondent 4 stated that *“people here sell vegetables and other food so cheaply, everyone in Accra comes to buy it. It is used in even the finest restaurants throughout the city.”* Expert Respondent 1 confirmed that *“almost everybody in Accra using products in some way from the site, especially food. My guess is people eating lunch at ministries in Accra have ingredients contaminated by Agbogbloshie because it is so integrated into the local economy.”* Figure 11 for example shows onions at the Agbogbloshie market being shipped to hotels across Accra.

Figure 11: Onions for sale at the Old Fadama Market within the Agbogbloshie neighborhood, 2019

Source: Author, with permission granted by the market vendors to be photographed. This particular market selling vegetables sits literally only a few meters away from noxious sources of air, dust, and water pollution from the e-waste scrapyard.

A final exposure pathway is smoke. Expert Respondent 11 supposed that *“I would generally say all of Accra is at risk because of Agbogbloshie. The southwest monsoon winds from the Gulf of Guinea blow into Accra, which mean the smoke from burning at Agbogbloshie is being carried into Accra central, exposing urban population, covering them with particulate matter, nitrogen oxide and flame retardants, and other carcinogenic pathogens.”* Expert Respondent 4 agreed that *“because of burning and smoke, all of Accra is at risk.”* Some of this smoke is shown in Figure 12. Fujimori (2016) and Wittsiepe et al. (2015) confirmed that the open burning of e-waste disperses many toxic pollutants far beyond the Agbogbloshie site.

Figure 12: E-waste burning for copper and its smoke, Agbogbloshie, 2019

Source: Author. Here, electronic waste is burned in the hopes of melting down the plastics and all non-essential or less valuable materials so that the more valuable ones, such as copper or gold, can be collected without having to manually dismantle each appliance or device.

5.9 Politicization, powerlessness and policy failure

A broader problem intersects with the political powerlessness of Agbogbloshie residents but also more generally the poor, as well as political uncertainty and policy failure at making their lives better. Community Respondent 12 explained that *“a big barrier is political, every new election changes the composition of the Accra Metropolitan Assembly, and thus the organization of the Scrapdealer’s Association. It shifts the entire management structure and the overlords.”* Expert Respondent 8 adds that *“the issue of e-waste and scrap is heavily politicized, because of the revenues and number of constituents at stake.”* Expert Respondent 9 remarked that *“any time the government changes, the leadership of the scrap dealers associate changes, it is a political institution. That is a huge challenge, one that has even led to gunshots in the past.”*

Connected with the politicization of scrapyards governance is, perhaps counter intuitively, one of community powerlessness and political helplessness. Community Respondent 1 said that *“some community members feel helpless trapped between the scrap dealers and workers, the criminal enterprises, and the government.”* Amuzu (2018) documents a longer history of political marginalization and exclusion of Agbogbloshie

residents, noting many have suffered forced evictions and relocations, and that such residents continue to lack recognition or participation in national policy discussions.

This politicization and powerlessness has led understandably to claims of policy failure within Ghana. On paper, Table 3 shows that Ghana has erected an impressive foundation of 18 policies over 40 years spanning the domains of energy efficiency, environmental monitoring, occupational safety, and trade and customs, as well as waste management and e-waste in particular. However, in practice enforcement is weak. Community Respondent 1 critiqued that “*all of the policies in place at the national level exist in paper only. Here, the problem is getting worse, not better.*” Expert Respondent 2 noted that the government only “*pays lip service*” to sustainability or e-waste, and that in simple terms, Ghanaian industrial strategy can be reduced to “*oil, gas, and gold.*” Expert Respondent 4 lamented that :

As a country, we understand how to make policies but we do not understand the impact of policies, or how to enforce them. We have an e-waste bill, we have all of these standards and regulations, highly applied, we know how to technically design policies, but we do not understand how to operationalize them and ensure they are implemented. There is a big problem of translating policy into enforcement and action. If the laws were to be enforced, the problem would already solved, and people would be in prison.

Expert Respondent 11 added that “*policy is not translated into the right kind of action, the right kind of people. Knowing this country, most policies are not well enforced.*” Oteng-Ababio and Grant (2019) critiqued that most policies in Accra, and Agbogbloshie in particular, seemed driven by “elite aspirations” to help the rich or the politically privileged rather than the poor.

Table 3: Global and national policy architecture in place for e-waste in Ghana, 1970 to 2018

Year	Policy	Description
1970	Factories, Offices and Shops Act	Seeks to protect the health and safety of workers from the dangers posed by chemicals to employees in the working environment in Ghana
1973	Standards Act	Sets health and safety standards for industry and manufacturing in Ghana

1974	Merchant Shipping (Dangerous Goods) Rules	Creates international maritime standards for the shipment or transshipment of hazardous materials and goods
1989	Mercury Act	Sets restrictions on the importation and use of products containing mercury (including electronics)
1989	Basel Convention	International convention seeking to reduce the movements of hazardous waste between nations, and specifically to prevent transfer of hazardous waste from developed to developing countries
1992	Customs, Excise and Preventive Service Law	Requires that the importation of hazardous items into Ghana are disclosed and reported to national authorities
1994	Environmental Protection Agency Act	Prescribes standards and guidelines relating to the pollution and the discharge of toxic wastes and control of toxic substances; coordinates activities and control the generation, treatment, storage, transportation and disposal of industrial wastes; and controls volumes, types, constituents and effects of waste discharges, emissions, deposits or other sources of pollutants and/or substances which are hazardous or potentially dangerous to the quality of life, human health and the environment
1995	Export and Import Act	Restricts and prohibits the importation of toxic or dangerous products and substances into Ghana
1998	Rotterdam Convention	An international treaty that promotes shared responsibilities in relation to importation of hazardous chemicals
1998	Bamako Convention	Sets more stringent waste import limits than the Basel Convention within African Union countries
1999	Environmental Assessment Regulations	Requires that all developmental activities likely to impact adversely on the environment must be subject to Environmental Assessment
2000	Draft Policy and Bill on Occupational Safety and Health	Seeks that measures are instituted to ensure the attainment of optimum health for workers in all occupations in Ghana
2001	Stockholm Convention	International convention that seeks to restrict or eliminate the production and use of persistent organic pollutants
2002	European Waste Electrical and Electronic Equipment Directive (WEEE Directive) 2012/19/EU	Developed to manage the end of life of electronics in the European Union and to improve the collection and efficiency of the recycling chain

2002	Restriction of Hazardous Substances Directive (RoHS Directive) 2002/95/EC	Restricts the use of certain hazardous substances in the production of electronics and electronic equipment
2007	Solving the e-waste problem (StEP)	United Nations program to promote reuse of recycled materials and improved control of e-waste flows
2008	Energy Efficiency Regulations	Sets restrictions in Ghana on the importation of energy inefficient lamps, refrigerators, freezers, and air conditioners
2016	Hazardous and Electronic Waste Control and Management Act	Prohibits imports and exports of e-waste in Ghana, phases out the inclusion of printed circuit boards in electronic equipment, provides for the registration of manufacturers, importers, and distributors, as well as the establishment of an e-waste management fund to be achieved through payment of an advance eco-fund by manufacturers, importers, and distributors

Source: Author's empirical data as well as Baldé et al. 2017; Kumar et al. 2017; Atiemo et al. 2016; Sthiannopkao et al. 2013; Schluep 2012.

5.10 Hacking, security and cybercrime

A final risk, the most global in scope, relates to data security and what is on the digital devices, hard drives, computers, and disks within the e-waste sent to Ghana. Community Respondent 1 remarked that “*activities at Agbogbloshie are connected to crime, there are all manner of criminal elements there.*” Expert Respondent 9 explained that “*It is plausible that there is a link to some criminal enterprises operating via Agbogbloshie by securing data and information from hard drives and other storage mediums.*” Grant and Oteng-Ababio (2012) acknowledged connections between Agbogbloshie and cyber security, data, and crime in their own research, emphasizing that many of the hard drives and devices have data and information on them that is “stolen.” The author also witnessed criminal linkages firsthand during one of the site visits, with one collector of green circuit boards onsite reputed to work for Nigerian organized crime (although this seemed more about managing revenues and collecting valuable materials, and not illicit data).

6. Policy recommendations for improved e-waste governance

A final part of our analysis relates not to benefits and risks, but policies for better managing e-waste in Ghana. Given the dynamic and multi-scalar nature of e-waste flows, this section has organized its suggestions across three different stakeholder groups: The producers or exporters of e-waste (primarily in Europe and North America), national planners and firms (primarily parliamentarians and national importers of e-waste), and e-waste

communities and workers (primarily onsite at Agbogbloshie). Table 4 offers a summary of these fifteen policy suggestions.

Table 4: Fifteen local, national, and global policy suggestions for better governing e-waste in Ghana

Scale	Illustrative stakeholders	Policy recommendation
Supra-regional and global	Firms making and exporting electronics equipment, European Union, United Nations	<ol style="list-style-type: none">1. Establish better inventories and data repositories for tracking and monitoring waste flows2. Convince e-waste exporters to better sort and separate waste flows3. Encourage upcycling and the right to repair to minimize e-waste flows4. Implement stronger reverse logistics and extended producer responsibility policies5. Properly contextualize the e-waste problem
National and regional	Government bodies such as the Ministry of Trade and Industry, Ministry of Gender, Child and Social Protection, Environmental Protection Agency or Ministry of Environment, Science, Technology and Innovation, municipal authorities such as the Accra Metropolitan Assembly, National Parliament	<ol style="list-style-type: none">6. Undertake improved customs screening and classification of imported waste flows7. Implement enhanced waste sorting and separation of wastes streams8. Increase financing flows and levy more substantial charges on e-waste9. Formalize some e-waste activities and build more recycling centers10. Complement formalization with poverty reduction programs and a respect for the

		informal e-waste sector
Local and community	Community groups such as the, e-waste workers, residents, associations such as the Greater Accra Scrap Dealers Association and the Scrap Dealers Association at Agbogbloshie	<ol style="list-style-type: none"> 11. Introduce education about e-waste and waste sorting in schools 12. Facilitate community involvement and stakeholder input into data collection 13. Create better training programs for e-waste sorting and dismantling 14. Provide protective gear and equipment to e-waste workers 15. Offer targeted medical and health care to Agbogbloshie residents

Source: Author

6.1 Supra-regional and global policy implications

At the largest scale, our evidence points towards five policy suggestions for intergovernmental groups such as the United Nations and European Union as well as the countries manufacturing electronics or exporting e-waste.

First, respondents suggested the international community needs better inventories of waste streams, tracking, and monitoring of e-waste flows. Expert Respondent 6 stated that “*we need a rigorous global waste development platform that can track which companies export or trade in e-waste, with which materials, and which waste streams.*” The backbone of this suggestion would relate to better data about e-waste flows. Baldé et al. (2017) for instance caution that only 41 countries publish official statistics about e-waste, and that by volume a large majority of global e-waste (34.1 million metric tons) is untracked and reaches unknown destinations. National regulatory bodies could assist with this task of a global repository of data. For instance, the Environment Agency in the United Kingdom already has a criminal intelligence team dedicated to detecting and tracking illegal waste shipments (Laville 2019). Such institutions could expand to track all waste flows and streams. This could even be done via new forms of monitoring such as placing GPS trackers on shipping containers or using advanced forms of remote sensing done via satellites (Basel Action Network 2019). Sthiannopkao et al. (2013) add that e-waste inventories, at the national or

even international level, should be fully conducted (covering all classes of e-waste) and publicly available.

Second, countries generating e-waste and exporting it should advance their techniques of waste sorting and separation, to go along with the enhanced identification of waste needed for the data inventory. Cui and Forssberg (2003) discuss a variety of techniques that readily exist to better separate and sort e-waste. This can include Eddy current separation for non-ferrous metals, corona electrostatic separation for other metals, and triboelectric separation for plastics, along with mechanical processes such as screening, shape separation, magnetic separation, and jigging. As Figure 16 indicates, such processes would help decompose e-waste into at least ten separate and more manageable (and identifiable) waste streams.

Third, our material implied that countries with large volumes of e-waste also focus more on upcycling and the right to repair, so that the lifetimes of electronic products are extended, and waste streams correspondingly reduced. Expert Respondent 8 stated *“it’s a mistake only to focus on the waste dimension of WEEE, instead upcycling opportunities exist where waste components are converted into something that lasts even longer than the original appliance, such as converting used washing machine drums into pots and pans, or circuit boards into desks, or stereo speakers into furniture.”* Expert Respondent 3 suggested that such efforts be coupled to local efforts such as the “right to repair.” Expert Respondent 3 commented that *“the EU and others need to force companies to make spare parts available for repairable electronic products and also emphasize the value of fixing and what has been called the right to repair—if that happens, there will certainly be a meaningful reduction in how much e-waste gets to Africa.”*

A fourth suggestion was stronger regulations on “reverse logistics” and extended producer responsibility, or EPR. Reverse logistics point to the problem of waste re-collection (Cross and Murray 2018). EPR would ensure that the manufacturers of electronic equipment, the “producers,” are responsible for recollecting e-waste. Expert Respondent 5 explained that *“true EPR schemes would ensure companies takeback their old products at the end of life, it would ensure those products are collected, treated, and properly recycled primarily in Asia, America, and Europe rather than finding their way here.”* EPR stipulates that producers are responsible for the entire lifespan of a product including at the end of its usefulness. To date, it has mainly been used for collection, recycling and waste management, but in concept it is also meant to also help drive more sustainable design as well as options for reuse and repair

(Canadian Council of Ministers of the Environment 2009). EPR would shift responsibility for the contaminants found in e-waste from local ministries and authorities in places like Ghana to major companies such as Apple, Samsung, and Toshiba (Daum et al. 2017). The European Union already erected its “Restriction of Hazardous Substances Directive” in 2003, to set a framework for EPR, but only in member countries and for selected toxins such as lead, mercury, and cadmium, or flame-retardants like PBDEs and PCBs. Thus, many producers, notably those in China, do not have to comply with EPR regulations.

A fifth and final suggestion was for the global community to properly contextualize the e-waste problem. That is, recognize that it is a growing and real concern, but also that it is but one symptom of overproduction of goods and materialist culture. Contextualizing also means acknowledging some of the benefits mentioned to e-waste (see section 4) rather than only its risks. Expert Respondent 8 mentioned they were “*tired of the hell on earth narrative*” surrounding Agbogbloshie, given how strongly many of the workers and community members support the scrapyard. Expert Respondent 5 added that this includes appreciating that e-waste is only a single part of a waste ecosystem, noting that: “*what we need are integrated waste policies that recognize the e-waste crisis but only alongside other equally pressing crises such as plastic waste, organic waste, and solid waste. From a climate perspective, organic waste is a far more important priority, given that many landfills do not capture methane and are just crude dumpsites responsible for potent greenhouse gas emissions. And plastic pollution likely poses a more serious threat to global marine ecosystems than e-waste.*” Expert Respondent 6 concurred and illustrated the necessity of a contextualized and integrated perspective specifically for Ghana: “*Accra is not only a city; it’s a giant trash can. The city acts as a catchment area for all sorts of waste and rubbish. Our landscapes are always polluted, our water is toxic, our fish stocks depleting and spawning grounds littered with plastics. Fish in our reefs cannot lay eggs; farmers trying to use rivers for fishing haul up 70% of plastic in their net rather than fish. Plastics are leeching into soils, littered on beaches, and drains are choked with plastic. E-waste is a low-volume and thus lower priority concern than plastic pollution. It needs placed in proper context.*”

6.2 National and regional policy implications

Our evidence suggests a range of policy instruments at the national or regional level alongside global ones. For example, countries such as Ghana that import e-waste could create stronger regimes of screening and waste classification. Expert Respondent 1 stated

“customs and trade officials need to be able to control what is coming in, to monitor flows and check for functionality, check for end of life, check weight, check types of products. With better tracking and tracing, government can plan and know when products will be obsolete.” Expert Respondent 3 added *“customs need to at a minimum know the quantity of materials flowing into Ghana.”*

Furthermore, Ghana could adopt improved waste sorting and separate techniques. This could mirror the recommendation above (in section 6.1) that exporting countries better separate, classify, and process waste. But Expert Respondent 5 went further, noting that *“we don’t want to only focus on e-waste within waste policy, we want to also be separating and sorting organic waste, which can form compost, and plastic waste, which can be recycled. Every day households literally throw value away in the form of these waste streams, this problem can be solved by national policies for waste separation and segregation.”* Expert Respondent 6 clarified that *“currently even when waste is sorted in Ghana, it usually ends up being mixed again in transit or at Agbogbloshie. Yet different waste types have different temporalities, collection rates and dynamics. Organic waste needs collected every day, or else it putrefies; it cannot be mixed with solid, metal, or e-waste. Paper from offices, and e-waste, can be collected every week or even every month. However, that requires separate trucks and delivery schedules. Our policy needs to recognize the complexity of these streams.”* These sentiments underscore the necessity of having an integrated national waste sorting policy or mechanism.

Better financing, or more specifically an enhanced fund for e-waste, could also help drive motivations to better sort and separate waste. Ghana currently does have a national e-waste levy, implemented since 2016, to help fund a \$30 million e-waste recycling facility that began construction at Agbogbloshie in 2018 (Business Ghana 2018). However, respondents suggested this levy was not high enough. Expert Respondent 5 articulated that *“it all boils down to financing, e-waste needs incentives that will exceed, not match, its market value if we are to expect compliance from informal e-waste workers.”* Expert Respondent 8 agreed and suggested that *“we need stronger financing mechanisms. Ghana has an e-waste fund, but the charges are meager. Unless we have robust charges the informal sector will always be at an advantage, and those in the formal economy can never compete.”* Baldé et al. (2017) confirm this is a common problem, noting that most formal recycling plants, such as those built in Kenya, Uganda, and Tanzania, end up closing down or suffering business failures due to insufficient levies or failed business models.

A connected concern is the stated need for further formalization of the e-waste sector. Respondents suggested this can include the involvement of more private sector actors, and the establishment of more commercial recycling centers. Expert Respondent 5 remarked that *“we need to capture market value for various people in the waste management supply chain, valorization and formalization of the people who collect waste and e-waste, clean it, separate it, and process it. This ensures they begin to participate in the formal economy, where they can be trained but also monitored and registered.”* Expert Respondent 6 also supported this mix of formalization and recycling centers, arguing that *“private sector involvement is key to an effective and efficient waste sector. The private sector has the knowledge, experience, and resources to effectively sort and process waste and e-waste. It is private companies that can also generate sustainable business models that can work independent of any subsidy.”* Atiemo (2016) reports that a multitude of commercial operators were at least trying to enter the e-waste market. Although they did not function well and focused only on cables, four automated wire-stripping units were housed in repurposed shipping containers in an attempt to create a commercial “Agbogbloshie Recycling Centre.” Atlantic Recycling International works on recycling or repairing obsolete ICT equipment; City Waste Recycling focuses on recycling sawdust, plastics, and some e-waste; FIDEV Recycling dismantles scrap metals; Blancomet Recycling also focuses on cable stripping and international scrap metal trading. One site the author visited, Akooshi Recycling Centre, recycled coconut husks into containers, bowls, and fragrances. Expert Respondent 6 suggested that *“Ghana desperately needs more recycling facilities, apart from those that handle e-waste, that we lack a national PET [polyethylene terephthalate] recycling center is a disgrace. A PET center would immediately address much plastic pollution.”* Expert Respondent 8 also indicated that KfW, the German Development Bank, was working to finance the completion of a \$25 million e-waste handling center that could collect waste and pay collectors.

However, and lastly, respondents strongly suggested that formalization by itself would never work unless also assisted by efforts to reduce structural poverty. Expert Respondent 1 stated that *“until we have a national campaign to address chronic poverty and provide basic amenities such as housing, water, education, and health, the underlying drivers behind hazardous informal activities such as e-waste will continue.”* They continued: *“the people of Agbogbloshie by and large don’t want to be formalized.”* Expert Respondent 3 agreed, and noted that *“we need to address the structural issues facing the poor, the drive for alternate employment, the need to survive, the need to take care of extended families, the*

need to tackle the unemployment problem, to make agriculture more viable, to build real skills and training ... The root problem is poverty: poverty is a devil that makes you do things you wouldn't ordinarily do." Amankwaa (2014) reached a similar conclusion when they noted that mechanisms for making progress with e-waste must also support the informal sector and reductions in poverty, and not merely seek to protect the environment.

6.3 Local and community policy implications

A final collection of policy changes would target the local and community level, especially the general public, local civil society organizations and e-waste workers themselves. One is to start educating youths, especially children in school, about proper waste management and e-waste. Expert Respondent 5 stipulated that *"waste sustainability starts in schools, we need to change the behavioral aspects of the Ghanaian citizens."* Expert Respondent 6 added that policy for sustainable w-waste needs to "catch them young," explaining that *"it is very difficult to make straight an old tree which is bent, it will just break. The idea is to catch them young, to start with the young generation, before attitudes become ingrained and difficult to change. Educate them early about e-waste and waste sorting."* Granted, this would be an intergenerational task, not an immediate solution, but it would ensure pro-sustainability values, if created, were transmitted to future generations.

One suggestion was to seek more community input and involvement in e-waste decisions and policies. This can help avoid mistakes, and enhance legitimacy. Expert Respondent 1 noted that *"when Green Advocacy brought in copper strippers for Agboglobhie, they were oversized, and didn't work well for the actual types of wire and quantities of copper ... All of these interventions were planned in some air conditioned office, with little engagement with the scrap dealers and community itself."* Expert Respondent 4 confirmed other questions arose over who would pay for the electricity for the stripping machines, and who would maintain them. Expert Respondent 4 concluded that often e-waste policy was made based on erroneous assumptions about what the community would prefer, many times emphasizing *"engineering based solutions with little to no real practical use."*

Multiple respondents stressed the need for better e-waste training for workers, especially for sorting and processing. The Environmental Protection Agency (2018) in Ghana created a handbook with guidelines for sound e-waste management for collectors, although many of these seemed onerous ("all collectors must register and complete forms") and impractical ("a collector shall not dispose outside of collection centers, and cannot burn

waste”). Nonetheless, Expert Respondent 8 added that “*better training programs are essential because they can endow the workers and their associations the knowledge they need to protect their own health.*” Expert Respondent 4 suggested that training, apart from focusing on “*standard recycling protocols,*” could even be in skills beyond waste management, such as those relating to “*marketing, accounting, and business management*” as well as skills that could be “*learned and transferred to other more lucrative jobs, such as welding, mechanics, or advanced repairing.*”

In tandem with training would be the provision of suitable protective gear and equipment to protect workers and reduce exposure. Expert Respondent 1 noted that “*donors have given e-waste workers gloves, goggles, and boots, but the types selected were too hot for the Ghana climate, the helmets too heavy.*” The key word here is *suitable*, i.e. what Expert Respondent 10 called “*adaptable to the Ghanaian climate and the types of work undertaken at Agbogbloshie.*” Such equipment would also differentiate for different tasks: lightweight masks that can filter toxins for burners, special clothing for those handling cadmium, lead, mercury, or arsenic.

Lastly, respondents discussed the provision of health care onsite at Agbogbloshie, beginning with a health clinic (currently being finalized as of early 2019) but moving towards more longer-term and comprehensive care. Expert Respondent 4 mentioned “*we are in the process of building a health clinic onsite, where we will offer health care at no cost to scrapyards workers, and screen youth and women. Qualified physicians and medics from the university will volunteer time in return for academic credit.*” Expert Respondent 11 suggested that while the clinic was a good first step, given it will be staffed by less than a dozen people and needs to serve thousands of possible community members, more clinics will be needed, perhaps even a hospital.

7. Future research directions

Our material lastly led to the identification of four suggestions for future research.

7.1 Unbundling e-waste to more specific products

E-waste is often treated in research as a holistic class of products, rather than specific devices or even brands. Expert Respondent 10 proposed that “*the research community needs to conduct more nuanced and specific research of specific firm supply chains or specific classes of technologies, such as electric vehicle batteries, solar panels, or refrigerators.*” This could be similar to the work that Sovacool et al. (2016) did for wind turbine

manufacturing, showing some of the externalities via an accounting of environmental profit and loss—including e-waste, incinerated waste, and waste sent to landfill—across the supply chain for offshore and onshore wind turbines in Northern Europe. Perkins et al. (2014) add researchers have an entire arsenal of tools at their disposal for focusing on the externalities of specified e-waste flows, including EPR alongside lifecycle assessment, material flow analysis, and multi criteria analysis.

7.2 Embedded ethnography and more inclusive research

It is also frequent in research, including this study, to conduct fairly isolated site visits, rather than embedding researchers more meaningfully, and over longer periods of time, in e-waste communities. Although one must be cognizant of the health risks, this would encompass having researchers stay with communities for weeks or even months. Expert Respondent 1 suggested such embedded ethnography would ensure the research gives back to the community: *“all too often the media and researchers come to Agbogbloshie and view them as a zoo or laboratory specimen, rather than an actual community with needs that research can address. Research must become more of a community thing, we need to stop treating them as merely a source of data that we extract for our articles, take what we want, and leave.”* Expert Respondent 11 added *“what we need is for researchers to embed themselves into the community, rather than being viewed as outsiders.”* Indeed, Expert Respondent 8 emphasized some creative communication channels that are already beginning to emerge to strengthen community relations with researchers, from an *“invisible theater”* that performs plays about e-waste disposal to *“speeches at durbars,”* large assemblies of the informal sector.

7.3 Transshipments and trade

This study only focused on Ghana, but a recurring theme relates to the complex and multi-scalar nature of e-waste flows, especially across transshipments and trade. Expert Respondent 1, Expert Respondent 9, and Expert Respondent 11 all noted that e-waste materials and repaired electronics are re-exported out of Ghana. Copper and gold in particular are shipped to China and Nigeria. Repaired electronics are exported to Benin, Togo, and even Sao Tome. The steel mill at Dawa processes scrap from Agbogbloshie but exports steel to all of West Africa. Future research can explore some of these transit points as well as how e-waste feeds and flows into transnational circulations of materials and goods.

7.4 Research on cocktails of pollution rather than isolated metals

A final suggestion was to enhance the environmental health research being done on e-waste, moving beyond individual pollutants to “cocktails” and beyond e-waste workers and local communities to others in Accra. Expert Respondent 4 noted that “*many teams have studied air, water, and urine at the site, but not food samples, which is critically important, given that Old Fadama market is huge and serves at least 10,000 people directly.*” Expert Respondent 11 added that “*too much research is on the basis of isolated toxins, we need to know what happens with complex mixtures of chemicals and cocktails of pollution.*”

8. Conclusions

To conclude, the tensions and tradeoffs in Ghana necessitate a recognition of the complex and multi-scalar nature of e-waste. What many producers of e-waste in the global North see as “junk” or “rubbish” is perceived as “valuable products” or “liberating technology” in communities such as Agbogbloshie. E-waste is neither wholly “good” nor “bad,” a finding echoed by Awamkwaa (2014). It instead becomes entangled in multiple dualities. E-waste is not only a problem of imports from the global North, it is a growing concern in the global South as domestic flows of e-waste continue to increase, driven by rising incomes as well as standards of status and cultural notions of prestige and patronage. This study identified no less than ten benefits to e-waste, including connections to freedom, livelihoods, poverty reduction and survival, and higher wages, alongside ten risks, including exposure to toxics, declining child and maternal health, and the contamination of foodstuffs. On top of these features, e-waste intertwines with patterns of ethnic migration, black markets, practices of child labor, familial structures, and how communities in Ghana are enmeshed with the priorities of poverty and survival.

Second, e-waste policy itself has a similar duality—part of the e-waste problem has been policy failure and a tendency for policies to exclude, marginalize, or misrepresent communities and the poor. Indeed, one of the core drivers of increasing levels of e-waste have been active policies in Ghana attempting to bridge the digital divide and bring affordable electronic products into the country. Other policies however have helped, including those creating an e-waste levy and establishing recycling centers, and those calling for better training of scrapyard workers. Taken as a whole, however, the policy regime in Ghana seems to be failing those at Agbogbloshie. We see a cascade of policy failures, including an inability to minimize ethnic conflict in the North, and mass migration to Accra due to lack of opportunities. We see unequal access to jobs and skills in Accra, and a lack of

protective gear at the site. We see the sobering presence of harmful activities and informal practices backed strongly by community support, and the seeming inability of national policy to create a commercially viable e-waste sector.

Third, corrective measures and recommendations do exist, but need to move beyond the simple binary frames of e-waste production and consumption. As Lepawsky (2014) has written, we need “a richer approach to the geographies of e-waste would add questions of reuse, repair, refurbishment and material recovery to the issue of trade flows and their environmental effects.” This study supports this contention, and it identified no less than fifteen different policy mechanisms that need to operate in concert across a variety of scales, from e-waste workers and their associations, to the metropolitan authorities of Accra, to national planners and even those in Asia, Europe, and North America producing electronics and exporting waste. Within these policy suggestions, it is equally apparent that formalization of the e-waste sector is just one of many suggestions, and it is unlikely to work unless structural inequality and poverty are addressed first. Otherwise, formalization will (at best) catalyze in other informal arrangements or incentives or (at worst) simply mask and obscure activities.

Fourth, given the first three conclusions—the complex duality of e-waste, the complex duality of policy, and the need for comprehensive policy reform—it is all but certain the future of e-waste will remain contested and conflicted. Someone stands to lose if e-waste patterns move in any direction (increased flows, decreased flows, increased exports, decreased exports); change disrupts at least one meaningful group of stakeholders. Put another way, e-waste operates within a complicated political economy where any attempt to reform livelihoods, manage practices, or monetize waste flows will alter power dynamics in ways that may only entrench unsustainability or inequality. Perhaps perversely, the more extensively embedded e-waste becomes to livelihood and identity in Ghana, the more exposed communities also become to its risk.

Fifth, and perhaps most important of all: the e-waste phenomenon in Ghana reminds us that the afterlives of electronic products are potentially long-lived and potent. Indeed, the very technologies we use in our modern increasingly digitized society—even the ones used in the digital camera doing the research, the digital audio recorder, the laptop, the emails sent to arrange meetings, the phone used to conduct site visits, and the computer or digital screen many readers will view this article on—are responsible for the risks presented here. It is a

sobering reminder that, as Amankwaa et al. (2017) and Puckett (2011) have so elegantly written, “away” is indeed a very real living, breathing, suffering “place.” It is a place, however, with conflicted toxic identities that are as vulnerable as they are likely to persist.

9. Appendix: Additional Data and Evidence

Table A1: Expert Research Interview Participants in this Study, 2019

<u>Respondent</u>	<u>Title</u>	<u>Institution type</u>	<u>Location</u>
ER1	Researcher	Academic	Legon, Ghana
ER2	Researcher	Academic	Legon, Ghana
ER3	Researcher	Academic	Legon, Ghana
ER4	Researcher	Academic	Legon, Ghana
ER5	Planner	Government	Accra, Ghana
ER6	Planner	Government	Accra, Ghana
ER7	Researcher	Civil society	Accra, Ghana
ER8	Researcher	Civil society	Accra, Ghana
ER9	Researcher	Academic	Accra, Ghana
ER10	Planner	Government	Accra, Ghana
ER11	Manager	Private sector	Accra, Ghana

Source: Author. Note: ER = Expert Respondent.

Table A2: Community Interview Participants in this Study, 2019

<u>Respondent</u>	<u>Title</u>	<u>Location</u>
CR1	Community Resident	Accra, Ghana
CR2	Scrap collector	Accra, Ghana (airport residential area)
CR3	Scrap collector	Accra, Ghana (airport residential area)
CR4	Scrap driver	Accra, Ghana
CR5	Repairer	Accra, Ghana
CR6	Repairer	Accra, Ghana
CR7	Chief	Agbogbloshie
CR8	Burner	Agbogbloshie
CR9	Burner	Agbogbloshie
CR10	Collector	Agbogbloshie
CR11	Repairer	Sege, Ghana
CR12	Former Chairman	Agbogbloshie
CR13	Manager for sorting	Agbogbloshie
CR14	Manager for repairing	Agbogbloshie
CR15	Manager for transport	Agbogbloshie
CR16	Dismantler	Agbogbloshie
CR17	Manager for weighing	Agbogbloshie
CR18	Chairman	Agbogbloshie
CR19	Vice-boss	Agbogbloshie

CR20	Vice-boss	Agbogbloshie
CR21	Vice-boss	Agbogbloshie

Source: Author. Note: CR = Community Respondent.

Table A3: Ghana Site Visits and Naturalistic Observation Conducted in this Study, 2019

<u>No.</u>	<u>Institution</u>	<u>Location</u>
1	Prodick Electrical	Accra, Ghana
2	Comfort Coolair and Electrical Services	Accra, Ghana
3	Progressive Electronics Technicians	Accra, Ghana
4	Kojo Broni Phone and Laptop Repairs	Accra, Ghana
5	Electricals	Accra, Ghana
6	Kojo God is King Electrical Works	Accra, Ghana
7	Old Fadama Market	Agbogbloshie, Ghana
8	Agbogbloshie scrapyard	Agbogbloshie, Ghana
9	My Son Electrical Shop	Sege, Ghana
10	Dawa Steel Mill / Export Zone	Dawa, Ghana
11	Adom Phone Repairs and Computer Hardware	Tema, Ghana
12	Samuel Refrigeration and Electrical Services	Dawhenya, Ghana
13	Republic Electrical	New Dawhenya, Ghana
14	Accra Compost & Recycling Plant (ACARP)	Accra, Ghana
15	Akooshi Recycling Centre	Accra, Ghana
16	Agbogbloshie scrapyard	Agbogbloshie, Ghana
17	Old Fadama Market	Agbogbloshie, Ghana
18	Agbogbloshie scrapyard	Agbogbloshie, Ghana
19	Old Fadama Market	Agbogbloshie, Ghana
20	Agbogbloshie Health Clinic	Agbogbloshie, Ghana

Source: Author

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