J Nat Env Sci 2010 1(1):43-47

Journal of Natural & Environmental Sciences

www.academyjournals.net

ISSN 1309 7474

Review Paper

Electronic revolution and electronic wasteland: The West/waste Africa experience

Orish Ebere Orisakwe[1a] and Chiara Frazzoli [2a]

[1] *Toxicology Unit, Department of Clinical Pharmacy, Faculty of Pharmacy, University of Port Harcourt, Rivers State, Nigeria*

[2]*Food and Veterinary Toxicology Unit and WHO/FAO Collaborating Centre for Veterinary Public Health –Department of Veterinary Public Health and Food Safety, Istituto Superiore di Sanità, viale Regina Elena 299, 00161 Rome, Italy.*

[a] *Noodles Onlus, Nutrition & food safety and wholesomeness, Italy*

Received: 16.09.2010 ***Accepted: 30.09.2010*** ***Published: 02.10.2010***

Abstract

In the name of bridging the digital divide between the developed world and countries in Africa, the African continent has become the world's latest destination for obsolete electrical equipment. The toxic nature of e-waste being transported to the continent, coupled with lack of efficient waste management system in the affected countries, has made the hazard transfer a subject of increasing global importance. E-waste is defined as "a generic term encompassing various forms of electrical and electronic equipment (EEE) that are old, end-of-life (EOL) electronic appliances and have ceased to be of any value to their owner," which is by far the best definition as of now. Given the volume of e-waste generated containing toxic materials, it is emerging as a risk to the society. Toxic pollutants are generated especially when e-waste is burned or recycled in uncontrolled manner.

Key words*: Electronic waste, Environmental pollution, Environmental health, Dumping, West Africa*

[*]*Corresponding Author: O.E Orisakwe, e-mail: eorish@aol.com, Phone:+22348068533281*

INTRODUCTION

The benefits of the information revolution are clear for all to see. Devices such as PCs, faxes, mobile phones, music players and a host of others open up exciting possibilities for individuals and businesses alike. Yet there is a downside to this digital era: the growing mountain of electronic waste. That electronic revolution has created wastelands is perhaps no longer debatable. The contemporary preoccupation however is the location of these wastelands and impact on the health of the local population in these wastelands. This mini-review is an attempt to look at these twin issues.

E-waste is the generic name for electronics wastes. These are discarded electronics devices or broken electronics or electrical items that come into the waste stream from several sources. They include gadgets like televisions, personal computers (PCs), telephones, air conditioners, cell phones, and electronic toys. The list can further be widened to include appliances such as lifts, refrigerators, washing machines, dryers, kitchen equipment or even air crafts.

Electronics equipment is one of the largest known sources of heavy metals, toxic materials and organic pollutants in city waste. E-waste is known to contain dangerous chemical pollutants that are released into the atmosphere and underground water. The modes of disposal, which include dumping old gadgets into landfills or burning in smelters, also expose the environment and humans to a cocktail of toxic chemicals and poison.

Concerns have been raised that toxic chemicals will leach from these devices when disposed (White et al. 2003). The toxic chemicals commonly used in electronic devices include metals and metalloids (e.g., arsenic, cadmium, chromium, copper, lead, and mercury) and organic chemicals such as brominated flame retardants (BFRs). The printed wire boards (PWBs, also referred to as circuit boards) found in most E-waste, for example, may contain arsenic, cadmium, chromium, lead, and mercury (Nordic Council of Ministers (NCM)1995, Five Winds International 2001). Cathode ray

tubes (CRTs) in computer monitors and televisions may contain barium, cadmium, copper, lead, zinc, and several rare earth metals (Five Winds International 2001). Lead is one heavy metal with known toxic properties that is found in large amounts in many electronic devices (Nordic Council of Ministers (NCM) 1995). Electronic devices, along with lead-acid batteries, are the major contributors of lead in the municipal solid waste stream (U.S. Environmental Protection Agency 1989). Lead-based solder (typically a 60:40 ratio of tin to lead), which is used to attach electrical components to PWBs, represents the major solder type used in most PWB applications (Nordic Council of Ministers (NCM)1995, Five Winds International 2001).

Typical PWBs have been reported to contain approximately 50 g of tin-lead solder/m^2 of PWB and approximately 0.7% of the total weight of a PWB (Electronic Industry Alliance 2000). In CRTs, leaded glass provides shielding from X-rays generated during the picture projection process. Color CRTs contain 1.6-3.2 kg of lead on average (Microelectronics and Computer Technology Corporation 1996).

And because they increase in concentration as they move up the food chain, PBTs can reach dangerous levels in living organisms, even when released in minute quantities. PBTs are harmful to human health and the environment and have been associated with cancer, nerve damage and reproductive disorders. Looked at individually, the chemicals contained in e-waste are a cocktail of dangerous pollutants that kill both the environment and humans slowly.

Since the mid-1990s, electronic waste (e-waste) has been recognized as the fastest-growing component of the solid-waste stream, as small consumer electronic products, such as cellular phones, have become ubiquitous in developed and developing countries (Widmer et al. 2005). In the absence of adequate recycling policies, the small size, short useful life-span, and high costs of recycling these products mean they are routinely discarded without much concern for their adverse impacts on the environment and public health. These impacts occur throughout the product life cycle, from acquisition of raw materials (Hayes et al. 2003) to manufacturing to disposal at the end of products' useful life. This creates considerable toxicity risks worldwide (Lincoln et al 2007, www.gridunep.ch/product/publication/ download/ew_ewaste.en.pdf.). For example, the mean concentration of lead in the blood of children living in Guiyu, China, a notorious destination for improper e-waste recycling (Stone 2009), is 15.3 µg/ dl. There is no known safe level of exposure to lead; remedial action is recommended for children with levels above 10 µg/dl (Huo et al. 2007).

Although this report, 'Toxic Tech: Not in Our Backyard' reveals the fate of millions of tonnes of e-waste generated each year is largely unknown. Much as this report claims that fate and therefore destination of e-waste is unknown, however the law of conservation of matter remains an all-time true scientific theory. If they wastes are not seen where they are produced, the implication is that they are somewhere. Large quantities of e-waste end up dumped in developing countries, where second-hand materials come mixed with broken junks and no infrastructure and protocols to safely recycle and dispose hazardous e-waste exist, nor legislation dealing specifically with e-waste flow. This is especially worrying in developing nations of West Africa (e.g., Nigeria, Ghana), which in recent years have become one major destination for obsolete electrical and electronic equipments EEEs worldwide: in Nigeria a preliminary survey found about 200 tons of e-waste material abandoned at riverbanks in dumping sites, where it is manually disassembled, repaired and marketed (Basel Action Network, BAN 2005).

Hungry for information technology but with a limited capacity to manufacture it, Africa has become the world's latest destination for obsolete electronic equipment.

Much of this material is more or less functional and provided in good faith by well meaning donors. But the brokers who arrange these exports often pad shipping containers with useless junk, essentially saddling African importers with electronic garbage.

BAN coordinator Jim Puckett, who visited Nigeria as part of that investigation, saw enormous piles of e-waste throughout the countryside, much of it routed through Lagos, Africa's largest port. "We saw people using e-waste to fill in swamps," Puckett recalls. "Whenever the piles got too high, they would torch them. Residents complained about breathing the fumes, but the dumps were never cleaned up. We saw kids roaming barefoot over this material, not to mention chickens and goats [which wind up in the local diet]."

Puckett says the dumps near Lagos could be the tip of an iceberg. No one knows for sure because there are virtually no data concerning the global e-waste trade—harmonized tariff schedules that dictate fees for export commodities don't assign codes to waste electronics other than batteries.

BAN's investigation—among the first of its kind in Africa—was limited to areas near Lagos, followed by a week-long foray into neighboring Niger, a landlocked country. Based on BAN's firsthand observations and other anecdotal reports, Puckett now believes e-wastes are passing through African port cities that, in addition to Lagos, include Mombasa, Dar es Salaam, and Cairo. Puckett didn't encounter e-waste in Niger and speculates that this is at least in part because the inland country has no port.

An estimated 500 shipping containers loaded with secondhand electronic equipment pass through Lagos each month, BAN's investigation found. Each container can be packed, on average, with a load equal in volume to 800 computer monitors or central processing units (CPUs), or 350

large TV sets. Local experts cited by BAN estimate that anywhere from 25% to 75% of this material is useless. Assuming the low end of this range, one could hypothesize that volumes of e-waste equal to 100,000 computers or CPUs, or 44,000 TV sets, enter Africa each month through Lagos alone. In the global village, toxic garbage does not go away. Eventually, this will surface as a serious problem. But that is yet another legacy transferring to future generations. E-waste related toxic effects can be perpetuated throughout life cycle and across generations (Frazzoli et al. 2010).

Why do African importers pay for electronic junk they can't sell? If the contents of shipping containers are purchased by weight, not by the combined value of what's inside them, then waste can be transported by "averaging" the load. It costs an average of US$5,000 to ship a 40-footcontainer full of used electronics from the United States to Africa, according to Jim Lynch, senior program manager for computer recycling and reuse at Compu- Mentor, a San Francisco–based nonprofit organization. Once there, some of this equipment can fetch a high price: Olayemi Adesanya, BAN's logistical coordinator in Nigeria, says a functional Pentium III computer sells for about US$130 on Nigerian markets, while a working 27-inch TV might sell for US$50. (Scrap components—especially working hard drives—can also be readily sold in Nigeria to supply an emerging reassembly industry.) Therefore, it doesn't take many working units to cover shipping costs. Indeed only 40 good Pentium III computers pay for an entire container, leaving a comfortable margin for profit even if the container is loaded with mostly unusable waste.

The question of who's selling e-waste to Africa is harder to answer. Used electronics travel murky routes populated by numerous recyclers and brokers working in an unregulated market, devoid of government certification programs. Electronics recyclers are at the top of the supply chain.

The fact that Ghana is a major dumping ground for e-waste from the US, Europe and other countries is undisputed, as evidence at the Agbogbloshie scrap yard and the number of used computer shops around the country have shown. The contents of some containers arriving at the Tema harbour have also revealed increasing amounts of e-waste entering the country, but steps towards stemming the ominous tide are slow.

Moreover, in Ghana one cannot find specific data on how much of the developed world's e-waste comes into the country, because records are simply not kept. But available data shows that as much as 75% of the 8.7 million tons of e-waste generated in the European Union cannot be accounted for, despite stringent regulations for recycling e-waste. In the US the figure is said to be about 80% or more because the amount of e-waste which is reported for recovery includes some of the e-waste exported to developing countries, according to Greenpeace, the international environmental group.

Ghana's case requires urgent attention, because should the side effects of the cocktail of toxic chemicals in e-waste hit the country, it would be disastrous, considering the fact that the country has no capacity either scientifically or medically to deal with the problem.

Ghana is a signatory to the Basel Convention, the international convention on the control of transboundary movements of hazardous wastes and their disposal. The EU also has the Waste Electrical and Electronic Equipment (WEEE) regulation to which its member countries subscribe. The WEEE directive stipulates that Information Technology (IT) manufacturers are legally responsible for the safe disposal of their products, and are obliged to ensure all products are disposed of in an environmentally friendly manner themselves or sign up with a government-approved waste-handling firm to do it on their behalf. And under this regulation, recycling companies receive some public funding to collect and properly dispose of e-waste safely.

But it appears some individuals have found loopholes in the system and are exploiting it by conniving with some organizations to collect broken electronics and electrical items for onward shipment to Ghana and other developing countries under the guise of aid. Some even sell these out as secondhand items. The broken items end up being sold to scrap dealers who dismantle and sell the parts, after burning the cables to extract the copper. Even well intentioned shipments of computers for reuse are being abused. In Ghana many traders report that to get a shipping container with a few working computers they must accept broken junk like old screens in the same container from exporters in developed countries. The broken junk and eventually even the working computers inevitably end up dumped in Ghana where there is no infrastructure to safely recycle toxic e-waste.

Challenges faced in e-waste management are not only the consequence of the growing quantities of waste, but also of the complexity of e-waste. E-waste is one of the most complex waste streams because of the wide variety of products ranging from mechanical devices to highly integrated systems and rapidly changing product design. Electronic products are an integration of numerous modern technologies and are composed of many different materials and components (Kang, and Schoenung).

As electronics increasingly become part of the throw away culture in many developed countries, amounts of e-waste have dramatically increased while solutions have often lagged far behind. Even in the European Union (EU) that has tighter regulation, 75 percent of e-waste is unaccounted for. Of the estimated 8.7 million tonnes of e-waste created annually in the EU a massive 6.6 million tonnes of e-waste is not recycled.

Literature data from some countries have been documented (Frazzoli et al 2010), where the widespread and severe contamination of all Chinese environmental compartments are shown. Unfortunately the weight and size of this scourge in many African countries which have become the major wastelands is largely unknown.

In a recent study in Nigeria, Nriagu et al 2009 found the mean blood lead level (BLL) among children to be 8.974.8 mg/dL and the median value was 7.8 mg/dL. About 160 children (25% of study population) had a BLL greater than 10 mg/dL. Blood lead levels (BLLs) in many western countries have progressively declined over the years. In Nigeria, however, high BLL have been documented not only in occupational cohorts but also in "unexposed" control subjects. The high BLL among controls cast doubts as how unexposed are these 'unexposed control subjects' actually are (Orisakwe 2009).

The journey from consumer to recycler is long and complex. It moves in a zigzag fashion. It involves players not only from the informal sector that is, the recycling stream, but also players from the formal sector, that is, manufacturers and retailers of computer items. Immediately after securing waste (e.g., computers) from various sources, scrap dealers face the dilemma of deciding which computer ought to be dismantled and which to be retained for resale. This dilemma arises because only a few models are in demand as secondhand products. Once the decision is made, the not-to-be-resold computer components find their way to the storehouses for dismantling. Sometimes, even a computer meant for direct reuse may ultimately end up in the storehouse as dealers cannot wait long for a prospective buyer (Schmidt 2006).

The first step in the process of computer disposal practices is the separation of each and every component. Monitor, monitor casing, motherboard, keyboard, floppy drive, hi-index, different components of the printer, etc., are all taken out manually and clubbed separately. The retailers and computer repair shop owners also sometimes do the segregation. These groups purchase only a few working chips of higher value. Otherwise, the majority of computer parts are broken up and sold off to different stakeholders for material recovery (Bandyopadhyay 2008).

GOVERNMENT ACTIONS IN CHECKING THE MENACE

Undoubtedly, poverty is partly responsible for this practice of importing used computers. The decreasing cost of replacing computers, mobile phones and other electronic gadgets is expected to reduce this practice. The increasing regulation of how unwanted electronic appliances are disposed of in developed countries has led to the dumping of such waste in poor countries where waste management is not co-ordinated. Unfortunately, Nigeria has become a favoured destination for the e-waste which the developed countries increasingly find difficult to dispose. Ominously, a recent study by the Basel Action Network shows that a minimum of 100,000 computers are cleared at the Lagos port every month. If the developed countries have problems dealing with e-waste, how do Nigeria which has no facility to dispose e-waste cope? For instance, Lagos State which hosts most of the ICT outfits in the country has no computer recycling plant. And with local experts estimating that close to 75 per cent of imported second-hand television sets, computer processing units and phones are e-waste, the plan to curb further import of e-waste is, to say the least, very timely. Government should, however, initiate a campaign to educate the consuming public on e-waste disposal techniques.

The risks arising from indiscriminate disposal of e-waste are startlingly high. It is scary that children who scavenge waste at various waste dumps in Nigerian cities are highly susceptible to toxic substances which could lead to cancer and other health complications. Government should begin to enforce legislation that punishes the indiscriminate disposal of e-waste. Any attempt by importers to fraudulently hide the identity of computers they import on Customs documents to avoid declaration at border points should be severely punished whenever it is detected.

CONCLUSION

There is no question that there is an imbalance of wealth in the world. More wealth leads to more consumption and ultimately to more waste. The United States Environmental Protection Agency reports that in 1999 alone, over 20,000 toxic waste generators produced more than 40 million tons of toxic waste in the United States (http://www.epa.gov/epaoswer/osw/basifact.htm). The European Commission reports that each year the European Union accumulates 1.3 billion tons of waste, of which about 40 million tons is hazardous. With each nation possessing finite space, a problem arises from the need to dispose of waste; this problem becomes more acute when the waste is hazardous. While arguably it is just that richer populations share their wealth with less fortunate countries, few would see the fairness in richer populations sharing their waste. This is especially true when such sharing of waste products is hazardous to the health of poorer populations. The sad reality, however, is that as consumption increases in developed countries, less developed countries (LDCs) are obliged to bear the brunt of the waste. Government should not allow the quest to bridge the digital divide to become a source of danger to the health of the people. Nevertheless, without banishing the scourge of poverty, efforts to stop the dumping of e-waste in the country will record scant success.

ACKNOWLEDGEMENT

We acknowledge the support of Noodles Onlus, Nutrition & food safety and wholesomeness, Italy (www.noodlesonlus.org).

REFERENCE

Bandyopadhyay A, 2008. Indian Initiatives on E-Waste Management—A Critical Review. Environmental Engineering Science **25** (10): 1507-1526

Basel Action Network (BAN), 2005. The Digital Dump: Exporting Re-use and Abuse to Africa

Frazzoli C, Orisakwe OE, Dragone R, Mantovani A, 2010. Diagnostic health risk assessment of electronic waste on the general population in developing countries' scenarios. Environmental Impact Assessment Review

Electronic Industry Alliance, 2000. The Evolution of Materials Used in personal Computers; Prepared for the OECD, Arlington, VA

Five Winds International, 2001. Toxic and Hazardous Materials in Electronics; Prepared for Environment Canada, National Office of Pollution Prevention and Industry Canada, Computers for Schools Program, Quebec, Canada

Hayes K, Burge R, 2003. Coltan Mining in the Democratic Republic of Congo: How Tantalum-Using Industries Can Commit to the Reconstruction of the DRC (Fauna & Flora International, Cambridge).

Huo et al X, 2007. Environ. Health Perspect. 115, 1113

Kang, HY, Schoenung, JM, 2005. Electronic waste recycling: a review of U.S. infrastructure and technology options, Resour. Conserv. Recycl. 45 (4) :368–400

Lincoln JD, Ogunseitan OA, Saphores JD, Shapiro AA, 2007. Environ. Sci. Technol. 41, 2572

Microelectronics and Computer Technology Corporation, 1996. Electronics Industry Environmental Road Map

Nordic Council of Ministers (NCM), 1995. Waste from Electrical and Electronic Products: A survey of the contents of materials and hazardous substances in electric and electronic products; Copenhagen, Denmark

Nriagu J, Afeiche M, Linder A, Arowolo T, Ana G, Sridhar MKC, Obi E, Orisakwe OE, Adesina A, 2008. Lead poisoning associated with malaria in children of urban areas of Nigeria. Int J Env Hyg Oct;211(5-6):591-605

Orisakwe OE, 2009. Environmental pollution and blood lead levels in Nigeria: Who is unexposed? Int Journal Occup Env Health. 15(3):315-317

Schmidt CW, 2006. Unfair trade: e-waste in Africa. Environmental Health Perspectives 114 (4): A232-A235

Stone R, 2009. Science 325, 1055. U.S. Environmental Protection Agency. Characterization of Products Containing Lead and Cadmium in Municipal Solid Waste in the United States, 1970 to *2000*; EPA/530-SW-89-015B; Office of Solid Waste: Washington, DC, 1989.

UNEP, 2005. E-Waste, the Hidden Side of IT Equipment's Manufacturing and Use. Environ. Alert Bull. 5, 1; www.gridunep.ch/product/publication/download/ew_ewaste.en.pdf

White C, Masanet E, Rosen C, Beckman SJ, 2003. Cleaner Prod., *11*, 445-458

Widmer R et al, 2005. Environ. Impact Assess. Rev. 25, 436