

Impact of E-waste on Environment and Health: A Critical Issue

Bharat Raj Singh^{1*} and Shrinkhala Srivastava²

¹Director General (Technical), School of Management Sciences,
Lucknow, 226501, Uttar Pradesh, India

²Assistant Professor, School of Management Sciences,
Lucknow, 226501, Uttar Pradesh, India

*Corresponding author: E-mail: brsinghko@yahoo.com; Phone: +91-9415025825

Abstract

Large quantities of electronic materials are being left in place as garbage around the world after the end of their useful life. Such waste is called E-waste. It produces hazardous pollution to the environment, which is non-biodegradable. In this way, the useful equipment related to electronic and electrical systems is also a form of pollution that arises due to collection of waste. Such electronic components and its parts those are collected and used for their reuse, resale, disposal, recycling or disposal, are also considered E-waste. Electronic scrap components such as computer CPUs mostly contain harmful components such as lead, cadmium, and beryllium or brominated artificial fragrances. In developed countries, workers and communities involved in recycling and disposal of E-waste is very risky as regards to their health issues. In landfills too much care is required to avoid the leakage of gases emanating from materials like heavy metals and also dangerous gases from the incineration ashes.

Keywords: E-waste, pollution, health impact, opportunities, recycling

Introduction

Growth in the IT and communication sectors has enhanced the usage of the electronic equipment's exponentially. Society today revolves around technology. There is very fast upgradation of technology. Because of which virtually, within a

short span of time, a constant need of upgraded electronic equipment's is being created by suppliers. Consumers are forced to discard old electronic goods very quickly, adding E-waste to solid waste stream. The growing problem of E-waste calls for greater emphasis on the recycling E-waste and better E-waste management. Rapidly growing technology, changes in media (software, recording-tape, MP3), affordable pricing, and planned obsolescence are resulting in a fast-growing surplus towards electronic waste globally. Although few technical solutions have to be thought over, but in general for many cases, a technical solution must be made available before implementing a legal solution, a collection, logistics, and other services.

It is known that display units like CRT, LCD, LED monitor, processors such as CPU, GPU, or APU chip, memory cord like DRAM or SRAM, and audio components have different distinct disposal lives. But most often they are replaced during its working even without its repair efforts. This is due to change in the rich nation and a race for new display technology. In most of the electronic gadgets their processors without upgradation of its software are changed declaring as outdated and are becoming E-waste. Such issues can be largely resolved with modular smart phones or phonebooks (Luthar & Kropivnik, 2015). These types of phones have enhanced durability as they have the technology to replace or few changes in the parts of the phone to make it environment friendly. While replacing the parts of the phone where it is broken may reduce E-waste (Smedley, 2013).

- Estimation shows that about 50 million tons of electronic waste is accumulated every year.
- 30 million computers are discarded by USA, each year and
- Each year, 100 million phones are made obsolete and thrown in Europe.

As estimated by The Environmental Protection Agency, only 15-20% of E-waste is recycled, the rest of these electronics go directly into landfills and incinerators (EPA, 2013, Gupta, 2012).

In 2006, for the amount of worldwide electronic waste, the United Nations estimated it to be 50 million metric tons every year (Blau, 2006). According to a report from UNEP (United Nations Environment Program), adding mobile phones and computers, recycling from E-waste to resource, the amount of E-waste produced in some countries, including India, may increase by 500 percent in the next decade (UNNS, 2010). The United States is the world's leading country in the production of electronic waste, where about 3 million tons of this waste is released each year. China being the second, already produces approximately 2.3 million tons (2010 estimate) domestically. And, despite the ban on E-waste imports, China remains a major E-waste dumping place for developed countries (UNU, 2010).

With the invention of the iPhone, the cell phones have become a top source for E-waste products as their usage is not being manufactured to last for more than two

years. Electrical wastes are also dangerous even to a certain limit, but they also contain some valuable and scarce materials. Nearly 60 elements can be found in complex electronics (Walsh, 2012). As of 2013, APPLE has sold more than 796 million of the iDevices (iPod, iPhone, iPad). The cell phone companies manufacture cell phones which are technologically not made to last long, compelling the consumers to purchase new phones. Seeing the consumer's desire for a new product, companies give such a short life span to these products because they know that if they make it, their purchase will definitely happen (ETBC, 2014). In the United States, an estimated 70% of heavy metals have been diverted from landfills that fall within electronics (Kozlan, 2010, Lotzof, 2020, SVTC, 2004).

Research studies have shown that, the acceptance towards the increasing number of discarded electronic devices, there is a considerable disagreement about the relative risk and strong disagreement whether limiting the trade in used electronics will improve conditions, or make them worse, is a matter to worry. According to an article published in *Vice*, attempts to limit the trade have driven reputable companies out of the supply chain, with unknown future consequences (Ingenthron, 2011).

China, Peru, Ghana, Nigeria, India, and Pakistan are the biggest recipients of E-waste from industrialised countries (Mmereki et al., 2016). The Basel Action Network (BAN) aims to ensure that E-waste is dealt with in an environment-friendly manner. It safeguards the planet from toxic waste trade. The BAN, Silicon Valley Toxic Coalition (SVTC), and Electronics Take-Back Coalition (ETBC) constitute an associated network of environmental advocacy NGOs in the US. The three organisations' common objective is to promote national-level solutions for hazardous waste management. Recent initiatives have been put forward such as 'E-Stewards', a system for auditing and certifying recyclers and take back programs so that conscientious consumers know which ones meet high standards.

Electronic Revolution and Culture

The electronic revolution has changed our lives. With the ease of mode of communication has brought people around the world closer. We are living in a great era of technological advancement and that we are a generation hooked up in advanced technology. We have gadgets of all types – from our appliances to our computers and laptops, to our ever-changing cell phones. Changing of gadgets has become similar as buying new clothes. Can you imagine what proportion electronic waste we generate? Where does it all go?

A culture of use and throw-away

E-waste is electronic devices and gadgets nearing or at the end of their useful life. It covers discarded obsolete electronic devices, cell-phones, notebooks, game consoles and their components.

Here are some electronic waste facts that you will find alarming:

- We generate around 40 million plenty of electronic waste per annum, worldwide. That's like throwing 800 laptops every second.

- An average cell-phone user replaces their unit once every 18 months.
- E-waste comprises 70% of our overall toxic waste.
- Only 12.5% of E-waste is recycled.
- 85% of our E-waste sent to landfills and incinerators are mostly burned, and release harmful toxins in the air!
- Electronics contain lead which may damage our kidneys and central nervous system.
- A child's mental development is often suffering because of low-level exposure to steer.
- the foremost common hazardous electronic items include LCD desktop monitors, LCD televisions, plasma televisions, TVs and computers with beam tubes.
- E-waste contains many substances, which are toxic. This includes mercury, lead, arsenic, cadmium, selenium, chromium, and flame retardants.
- 80% of E-waste in the US and most other countries are transported to Asia.
- 300 million computers and 1 billion cell-phones go into production annually. It is expected to grow by 8% per year.

Is E-waste Bad?

Major amount of E-waste is found in Asia or Africa landfills. The recycling method in these landfills isn't the "recycling" that we've in mind. E-waste is bad for our planet and above all for the workers on the landfills. It is buried or incinerated in landfills where the toxins produced by them pollute our land, air and water. Most of the time, they're sent to developing countries where workers extract precious metals from discarded electronics. Workers on E-waste sites are paid a mean of \$1.50 per day. They are unprotected while working with the toxic substances on the location. Primarily they are susceptible to inhale the toxins that are released within the air when electronic parts are burned. Many of these workers are children or adolescents.



Figure 1(a) and (b) Electronic waste at shop and disposed places

(source: Wikipedia)

Why we should recycle Electronics

- Cell-phones and other electronic devices contain precious metals like gold and silver. The US alone throws away cell-phones with \$60 million worth of gold/silver yearly.
- Recycling 1 million laptops save the energy equivalent to the energy used by 3600 homes in the US annually.
- Most of the components of E-waste are equipment which will be re-used and recycled for materials recovery.

What can we do about our personal E-waste?

We can explore several options when it involves the right disposal of your electronic devices.

- Your old cell-phone can still be used by another person. Same can be done with our old computer or television. Donate it to friends, charities or community outreach programs – even to a stranger! This is better than the hazardous E-waste materials ending up during a landfill somewhere. It's a win-win option!
- Find a certified E-waste recycler. Those who aren't certified will just send it off elsewhere where it can again do its damage.

Be a part of the answer and help reduce electronic waste. One cannot be stopped from changing their devices, but can discard their old ones properly. When it involves E-waste, there's probably another person within the world who can enjoy your unwanted devices. Find them before you throw it away. Let's keep our electronic waste as distant from landfills as possible.

Handling of Electronic Hazardous Waste (E-waste)

Removing E-waste in landfills has the potential to cause severe damage human and environmental health impacts. To avoid these risks, the Electronic Waste Recycling Act – Senate Bill 50 (SB 50) was signed into law in 2004. It established and funded a program for consumers to return, recycle, and ensure safe and environment friendly disposal of covered electronic devices (CEDs).

Department of Toxic Substances Control (DTSC), has also adopted regulations (Chapter 23 of Title 22 of the California Code of Regulations) designating E-wastes as universal wastes. Because they pose a lower immediate risk to people and therefore the environment when properly managed, universal wastes are often handled and transported under more relaxed rules compared to hazardous wastes. However, E-wastes contain hazardous materials and must be taken to a certified handler or recycler. Find an E-waste handler or recycler in your county, or visit the Cal Recycle's Directory of the businesses that collect, reuse and recycle electronic wastes.

Information for E-waste Handlers and Recyclers

There are several reporting requirements to be processed about before becoming an E-waste handler. DTSC has prepared several guidance documents and newsletters on complying with our regulations. Under California law, generators are responsible for determining whether their E-waste is hazardous waste (Cal. Code Regs, tit. 22, Section 66262.11).



Figure 2 Junk of Old Keyboards and Mouses

(source: EPA, 2013)

E-waste Legislation and Regulation

DTSC regulates and enforces this Electronic Waste Recycling Act whereas the Department of Resources Recycling and Recovery (Cal Recycle's) manages the payment system (DTSC, 2002).

- A look should be given to new universal waste regulations that were adopted on February 4, 2009. This version is in boldface where significant changes were made.
- and also, a summary table summarising substantial amendments to the universal waste regulations.
- The DTSC workshop presentations must be viewed: Preparing for a DTSC Inspection of E-waste recycling facility, Mini-Workshop for Universal Waste Handlers.

Managing Discarded Cell Phones

Unwanted cell phones are regulated as universal waste electronic devices in California. Under the phone Recycling Act of 2004, retailers who sell cellular telephones are required to need them back from consumers. DTSC has prepared a fact sheet that explains the provisions of this law. This area still needs attention in Our Country Too.

E-Waste and Its Negative Impact on Environment

The processes of dismantling and removing electronic waste in developing countries led to sort of environmental impacts as illustrated within the graphic (Figure 3). Liquid and atmospheric releases can be carcinogenic. They end up in contaminating water, soil and air thus affecting flora and fauna. The drinking water taken or the crops grown in contaminated soil may be later consumed by human being and animals as well in land which can have hazardous results in long term (Frazzoli et al., 2010).

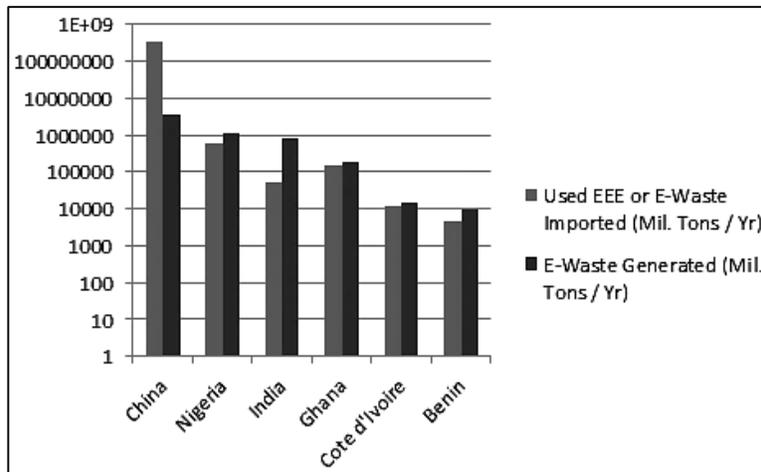


Figure 3 Environmental Impacts of E-waste in different Countries

(source: CONS200/ *The story of Canada's digital dumping ground*)

The study of effect of E-waste on environment was made in Guiyu, China which reveals following points (Sthiannopkao & Wong, 2013):

- Airborne dioxins –come under the category of Persistent Environmental Pollutant. They are highly toxic for a living being, with a half-life of 7 to 11.
- Levels of carcinogens in duck ponds and rice paddies including cadmium, copper, nickel, and lead levels exceeded international standards for agricultural.
- Heavy metals found in road dust – lead had 300 times an impact on village's road dust and copper over 100 times

The environmental impact of the processing of various electronic waste components has been shown in Table 1.

Table 1 Different Electronic Waste Components and Potential Environmental Hazard

E-waste Component	Process Used	Potential Environmental Hazard
Cathode ray tubes (used in TVs, computer monitors, ATM, video cameras, and more)	Breaking and removal of deflection yoke and then dumping	Lead, barium and other heavy metals leaching into the ground water and release of toxic phosphorous
The computer circuit board (image behind table – a thin plate on which chips and other electronic components are placed)	De-soldering and removal of computer chips; thereafter, open burning acid baths to remove metals.	Air emissions and discharge of glass dust, tin, lead, brominated dioxin, beryllium cadmium, and mercury into rivers.
Chips and other gold-plated components	Chemical stripping using nitric and hydrochloric acid and burning of chips	Polycyclic aromatic hydrocarbons (PAHs), heavy metals, brominated flame retardants discharged directly into rivers acidifying fish and flora. Tin and lead contamination of surface and groundwater. Air emissions of brominated dioxins, heavy metals, and PAHs
Plastics from printers, keyboards, monitors, etc.	Shredding and low temperature melting to be reused	Emissions of brominated dioxins, heavy metals, and hydrocarbons
Computer wires	Open burning and stripping to get rid of copper	PAHs released into air, water, and soil.

E-waste Problem in India and Therefore the Impact on Health

E-waste Problem in India

India ranks 177 amongst 180 countries and is amongst the lowest five countries on the Environmental Performance Index 2018, as per the report released at the earth Economic Forum 2018. This was linked to poor performance within the environment health policy and deaths because of pollution categories. Also, India is ranked fifth within the planet amongst top E-waste producing countries after the USA, China, Japan, and Germany and recycles but 2 per cent of the entire E-waste it produces annually formally. Since 2018, India has generated quite two million tonnes of E-waste annually and also imports huge amounts of E-waste from other countries

around the world. Dumping in open dumpsites may be a common sight that provides rise to issues like groundwater contamination, poor health, and more. With the help of The Associated Chambers of Commerce and Industry of India (ASSOCHAM) and KPMG study, Electronic Waste Management in India identified that computer equipments account for nearly 70 per cent of E-waste, followed by telecom system phones (12 per cent), electrical equipment (8 per cent), and medical equipment (7 per cent) with remaining from household E-waste.

E-waste collection, transportation, processing, and recycling are dominated by the informal sector which is well networked but unregulated. Often, the value for all the materials that would be potentially recovered isn't recovered and creates serious issues regarding leakages of poison into the environment questioning workers' safety and health (see Figure 4).

E-waste Impact on Health

Electronic waste contains toxic components like mercury, lead, cadmium, polybrominated flame retardants, barium and lithium. The negative health effects of these toxins on humans include brain, heart, liver, kidney and skeleton damage. It can also considerably affect the nervous and reproductive systems of the human body, leading to birth defects and several other disorders. Improper disposal of E-waste is unbelievably dangerous to the worldwide environment, which is why it is so important to spread awareness on this growing problem and thus the threatening aftermath. The growing stream of E-waste will only worsen if not educated on the proper measures of disposal.

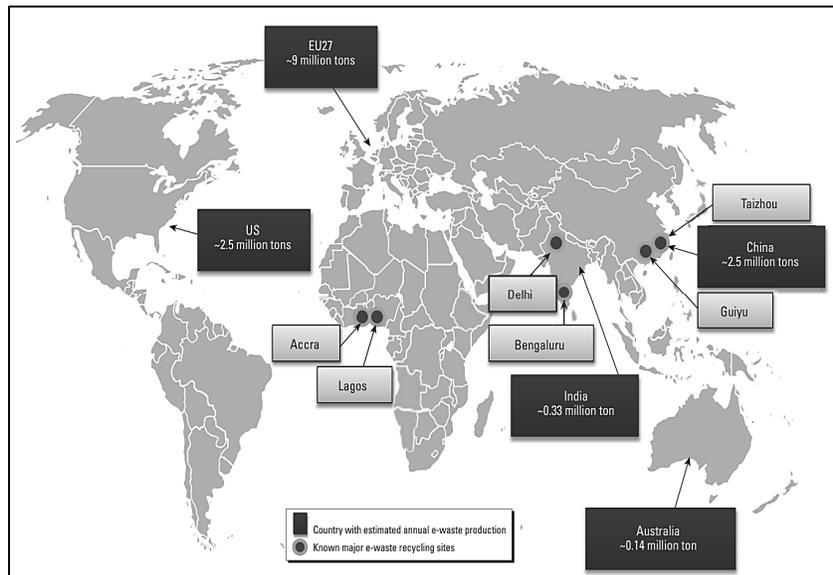


Figure 4 Global E-waste Issues (Chen, 2010)

Health Issues in Developing World

Most E-wastes contain some sort of recyclable material, including plastic, glass, and metals; however, thanks to improper disposal methods and techniques these materials can't be retrieved for other purposes. If E-waste is dismantled and processed during a crude manner, its toxic constituents can wreak havoc on the human body. Processes like dismantling components, wet chemical processing, and incineration are wont to eliminate the waste and end in direct exposure and inhalation of harmful chemicals. Safety equipment like gloves and face masks aren't widely used and workers often lack the knowledge required to carry out their jobs properly.

Health Issues in India

Manual extraction of toxic metals results in entering of dangerous material within the bloodstream of the individual doing so. The health hazards range from kidney and liver damage to neurological disorders. Recycling of E-waste scrap is polluting the water, soil, and thus the air. Burning to retrieve metal from wires and cables has led to the emission of brominated and chlorinated dioxins also as carcinogens which pollute the air and, thereby, cause cancer in humans and animals. Toxic chemicals that haven't any value are simply dumped during the recycling process. These toxic chemicals leach into underground aquifer thereby degrading the local groundwater quality and rendering the water unfit for human consumption also as agricultural purposes.



Figure 5 Hazardous Landfills & Health Issues in India

When E-waste is dumped in landfills, the lead, mercury, cadmium, arsenic, and Polychlorinated biphenyls (PCBs) make the soil toxic and unfit for agricultural purposes. Very recent studies on recycling of E-waste have pointed towards increasing concentrations of PCBs, dioxins and furans, plasticizers, Bisphenol-A (BPA), PAHs, and heavy metals within the surface soil of the four metro cities of India, that is, New Delhi, Kolkata, Mumbai, and Chennai (see Figure 5), where E-waste is being processed by the informal sectors. In those studies, it has been observed that the sites engaged in metal recovery processes are the prime sites for

such persistent toxic substances. Studies from an equivalent group also reported that the persistent organic pollutants produced or released during the recycling process are escaping within the ambient air, thanks to their semi-volatile nature.

Opportunities of E-waste Management in India

The Ministry of Environment, Forest and global climate change, unrolled the E-waste (Management) Rules in 2016 to reduce E-waste production and increase recycling. Under these rules, the government introduced Extended producer responsibility (EPR), which makes producers significantly responsible to collect 30 per cent to 70 per cent (over seven years) of the E-waste they produce.

E-waste could also be an upscale source of metals like gold, silver, and copper, which can be recovered and brought back to the assembly cycle. There is significant economic potential within the efficient recovery of valuable materials in E-waste and may provide income-generating opportunities for both individuals and enterprises. The E-waste Management Rules, 2016 were amended by the govt in March 2018 to facilitate and effectively implement the environmentally sound management of E-waste in India. The amended Rules revise the gathering targets under the availability of EPR with effect from October 1, 2017. By way of revised targets and monitoring under the Central Pollution Control Board (CPCB), effective and improved management of E-waste would be ensured.

How to Reduce the E-waste

How can we combat this growing problem of electronic waste? By re-cycling! The question arises in one's mind; Recycling is already complicated enough, how to recycle certain sorts of plastics, a computer or computer disk from 1998?

Inspect some quick and straightforward solutions to urge you on the road to recycling.

- Offer your old E-waste for free/barter or sale on sites like Craigslist and Freecycle.org. Someone's trash is someone else's treasure, especially when that someone else might be an inventor or electrician who can make something new out of something old.
- Upcycle! Get creative and see how you can reuse or repurpose your E-waste, especially as art or home decor. CD coasters? Computer screen picture frame? Check out products in our Green Marketplace created from E-waste, including these earrings made up of old CDs. Improved lifecycle management of electronics and electrical equipments, through source reduction of materials used, increasing reuse, refurbishing, extending the life of products, and recycling of electronics, can reduce the total quantity of waste that needs to be managed domestically and globally.

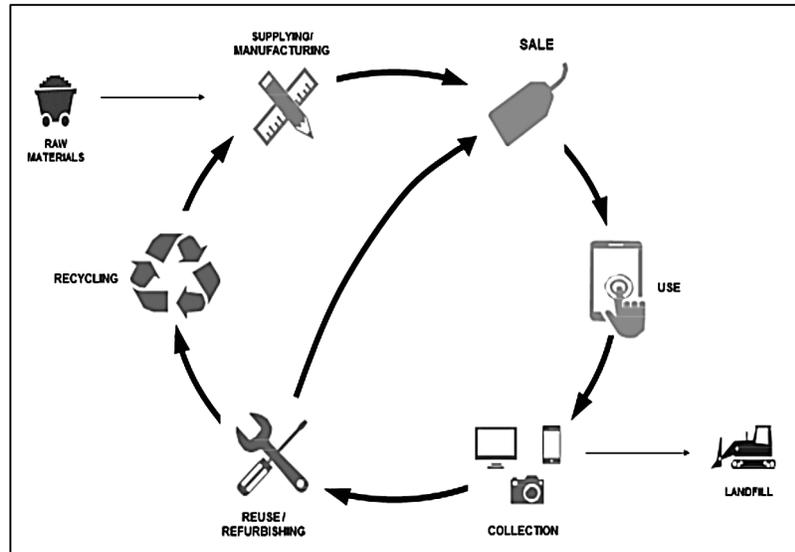


Figure 6 Life Cycle Stages of Electronics and Electrical Equipments

(source: EPA, 2013)

Summary of the Chapter

From the above chapter we studied that when the E-waste isn't properly handled and easily thrown out with the rubbish or ending up during a landfill, it means both human health and the environment are at risk. E-waste is filled with a veritable of toxic materials that affect human & animal body and the environment such as:

- (i) Lead and cadmium, cause brain damage, cancer etc.
- (ii) Mercury causes damage to the brain and nerves system.
- (iii) Brominates flame retardant
- (iv) Poly chlorinated biphenyls (PCBs)
- (v) Polyvinyl chloride (PVC)

Thus, we have to handle E-waste very carefully and recycle it as much possible as it can be. If at all it is needed to be disposed-of, it can be landfilled at unused places. The government must announce incentives, which might be within the sort of tax concessions or rebates, to make sure compliance across the industry. Additionally, the E-waste collection targets got to be regularly reviewed and renewed to make sure compliance across India on the gathering of E-waste.

Questions

1. How electronic waste is becoming serious problem worldwide – Explain it in details?

2. What is the E-waste Legislation and Regulation and why it is necessary to follow judicially?
3. What methods are required to be followed to reduce ill effect by each and every developing country?
4. Whether standardisation of electronic devices like: TV, VCR, Computers, Telephones, mobiles or other useful gadgets should follow to reduce E-waste?
5. How waste landfills can help in reducing health hazards? Explain in details.
6. What kind of research and technological development for reduction of electronic waste can be helpful in reducing environmental hazards?

References

- Luthar, B., Kropivnik, S. (2011). "Class, cultural capital, and the mobile phone." *Czech Sociological Review*, 47(6), 1091–1118. <https://doi.org/10.13060/00380288.2011.47.6.01>
- Smedley, T. (2013, 18 Nov.). "Is phonebloks really the future of sustainable smartphones?" *The Guardian*. <<https://www.theguardian.com/sustainable-business/phonebloks-future-sustainable-smartphone>
- EPA (2013). "Statistics on the management of used and end-of-life electronics." *US Environmental Protection Agency*. Washington, D.C., USA. <https://www.epa.gov/smm-electronics/basic-information-about-electronics-stewardship#01>
- Gupta, D. (2012). "E-Waste: A Global Problem and related issues." *International Journal of Scientific & Engineering Research*, 3(10), 1–12. <https://www.ijser.org/researchpaper/E-Waste-A-Global-Problem-and-related-issues.pdf>
- Blau, J. (2006, Nov. 27). *UN summit to address issue of growing e-waste*. InfoWord. <https://www.infoworld.com/article/2661264>
- UNNS, United Nations News Service (2010, Feb. 22). *As E-waste mountains soar, UN urges smart technologies to protect health*. United Nations News. <https://news.un.org/en/story/2010/02/330172-e-waste-mountains-soar-un-urges-smart-technologies-protect-health>
- UNU. (2010). *Urgent need to prepare developing countries for surges in E-waste*. United Nations University, Tokyo, Japan. <https://unu.edu/media-relations/releases/urgent-need-to-prepare-developing-countries-for-surge-in-e-wastes-un.html>
- Walsh, B. (2012). "E-waste: How the new iPad adds to electronic garbage." *Time*. <https://science.time.com/2012/03/08/>
- ETBC. (2014, June 25). "Facts and figures on E-waste and recycling." *Electronics TakeBack Coalition*. <http://www.electronicstakeback.com>
- Kozlan, M. (2010, Nov 2). *What is E-waste & how can I get rid of it? Four Green Steps*.
- Lotzof, K. (2020). "What is E-waste and what can we do about it?" *National History Museum*. <https://www.nhm.ac.uk/discover/geology.html>
- SVTC. (2004). "Poison PCs and toxic TVs." *Silicon Valley Toxics Coalition*. <http://www.svtc.org/wp-content/uploads/ppc-ttv1.pdf>

- Ingenthron, R (2011, March 31). "Why we should ship our electronic waste to China and Africa." *Vice*. <https://www.vice.com/en/article/d77w9m/e-waste-recycling-exports-are-good>
- Mmerek, D., Baldwin, A. N., & Baizhan, L. (2016) "A comparative analysis of solid waste management in developed, developing and lesser developed countries." *Environmental Technology Reviews*, 5(1), 120–141. <https://doi.org/10.1080/21622515.2016.1259357>
- DTSC. (2002). *Hazardous waste generator requirements fact sheet*. Department of Toxic Substances Control. <https://dtsc.ca.gov/hazardous-waste-generator-requirements-fact-sheet/>
- Frazzoli, C., Orisakwe, O. E., Dragone, R., Mantovani, A. (2010). "Diagnostic health risk assessment of electronic waste on the general population in developing countries' scenarios." *Environmental Impact Assessment Review*, 30(6), 388-399. <https://doi.org/10.1016/j.eiar.2009.12.004>
- CONS200/The story of Canada's digital dumping ground. https://wiki.ubc.ca/Course:CONS200/The_story_of_Canada%27s_digital_dumping_ground
- Sthiannopkao, S., Wong, M. H. (2013). "Handling e-waste in developed and developing countries: Initiatives, practices, and consequences," *Science of The Total Environment*, 463-464, 1147-1153. <https://doi.org/10.1016/j.scitotenv.2012.06.088>
- Chen, A., Dietrich, K. N., Huo, X., Ho, S. (2010). "Developmental neurotoxicants in E-waste: an emerging health concern." *Environmental Health Perspectives*, 119(4), 431–438. <https://doi.org/10.1289/ehp.1002452>
- Manish, A., Chakraborty, P. (2019). "E-waste management in India: challenges and opportunities." *The Energy and Resources Institute*. <https://www.teriin.org/article/e-waste-management-india-challenges-and-opportunities>