The toxicological implications of e-waste

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Here, Donald A. Bruun and Pamela J. Lein discuss the toxicological implications of e-waste and how to address this global problem

The planet's increasing thirst for technology comes at a significant cost: the global problem of electronic waste or e-waste. E-waste is any product containing electronic components that has reached the end of its usable life cycle. In 2019, the world discarded an estimated 53.6 million tonnes of e-waste, a volume expected to double in the next 15 years. The United Nations estimates less than 17.4% of e-waste is recycled, so most ends up in landfills.

Unbeknownst to many consumers, electronics contain over 1,000 chemicals considered hazardous to human health, and the consequences of improper e-waste disposal pose serious threats to human health and the stability of ecosystems.

The Basel Convention

The Basel Convention, an international treaty designed to reduce the movement of hazardous waste between countries, began addressing e-waste in 2002. Current action items include preventing the illegal trafficking of e-waste to developing countries and building environmentally sound capacity around the globe to better manage e-waste. Unfortunately, e-waste regulations are largely unenforced, particularly at the local level.

In the United States, which did not participate in the Basel Convention, e-waste currently constitutes 2-3% of the U.S. municipal solid waste stream, yet it represents almost 70% of the toxic waste stream. For example, the average cathode ray tube (CRT) computer screen contains at least five to eight pounds of lead, representing 40% of all lead in U.S. landfills. Researchers at Carnegie Mellon University estimate there are 70 million computers in U.S. landfills, indicating a significant missed opportunity for recycling CRTs.

Disposal of e-waste

Improper disposal of e-waste in regular landfills or illegal dumping of e-waste has resulted in the leaching of flame retardants and heavy metals, such as mercury, lithium, lead and barium, into the soil and groundwater. These contaminants eventually enter ponds, streams, rivers and lakes, a process that is accelerated by acidic water (e.g., from acid rain, industrial and consumer waste), which increases the leachability of heavy metals. When mercury is combined with anaerobic decaying organic waste, it generates methylmercury, a more toxic form of the metal. Burning e-waste can generate dioxins, furans, polycyclic aromatic hydrocarbons (PAHs), polyhalogenated aromatic

hydrocarbons (PHAHs) and hydrogen chloride, some of which are carcinogenic, all of which are toxic. Thus, animals, plants, and communities – even those miles away from a recycling site – may be exposed.

Many consumers in developed countries conscientiously recycle their e-waste, but are unaware that it may be shipped miles away to be processed at unregulated or "informal" recycling centres in developing countries. A study by the watchdog group Basel Action Network found that 40% of the e-waste supposedly recycled in the U.S. was actually exported. Most of it ended up in developing countries – usually in Asia and Africa – where recycling is typically unlicensed and unregulated. Two of the largest informal recycling centres in the world are in the Guiyu area, China and Agbogbloshie in the heart of Accra, Ghana, both considered to be among the most polluted places on Earth.

Recycling centres in developing countries

Studies of recycling centres in developing countries have found elevated levels of hazardous metals and organic compounds in the soil, water, and air of surrounding communities, and in the blood, urine and hair of not only e-waste workers, but also people who reside or work close to e-waste recycling sites. Men, women and children who recover valuable materials at unregulated recycling sites often dismantle devices by hand to reclaim materials of value. Devices are often burned to melt away non-valuable materials, while mercury and acids are used to recover gold. Typically, workers are not aware they are handling hazardous materials and so do not wear protective equipment. Individuals engaged in "cottage" recycling within the home have no protection at all. These attempts to earn a living wage often result in early death.

The problem of e-waste toxicity

Exposure to the harmful chemicals present in e-waste can occur by inhalation, skin absorption, or ingestion. Inhaling toxic chemicals or direct contact with hazardous e-waste materials (even in some formal e-waste recycling settings) is associated with increased incidence of spontaneous abortions, stillbirths, premature births, reduced birth weights, mutations, congenital malformations, abnormal thyroid function, decreased lung function and neurobehavioral disturbances.

To address the growing worldwide problem of e-waste toxicity, manufacturers need to prioritise the easy disassembly of electronics rather than exacerbate the problem. For example, Apple computers now have the battery glued in with no removable components. Regulations that are in place need to be better enforced. There are powerful incentives to develop and enforce more effective approaches for recycling e-waste. It is estimated that $60 million in gold and silver enter the U.S. e-waste stream every year from discarded phones and precious metals in circuit boards are more concentrated than in the most productive mines. In 2016, the gold in the world's e-waste equalled more than a tenth of the gold mined globally that year. Although valuable metals and rare-earth elements are scarce and some, like cobalt, are found mostly in conflict zones, much of this treasure is currently being buried in landfills.

These factors – coupled with the increasingly efficient and eco-friendly methods for extracting metals from e-waste – are compelling tech manufacturers to investigate obtaining raw materials from their own end-of-life products rather than from the Earth. Many new processes for recovery of the precious metals from e-waste, such as crushing electronic materials and separation by sieving or chemical means are coming online. To reduce toxic dust created by these processes, some groups are exploring nanotube technology and others are looking at sound waves to break components into smaller sizes. In the Swedish town of Skellefteå, local smelters are using automated technologies to smelt 88,000 tonnes of e-waste per year. Another company in Belgium claims it obtained 95% useful products from e-waste.

Minimise the toxicological impacts of e-waste

As the world demand for electronics increases, we must develop responsible legislation to increase the use of new recycling technologies to minimise the toxicological impacts of our growing e-waste.

Please Note: This is a Commercial Profile

More About Stakeholder

UC Davis Department of Molecular Biosciences

The Department of Molecular Biosciences serves as the academic home for all nutritional, physiological chemistry, and pharmacologic and toxicologic programs of the School of Veterinary Medicine at UC Davis. The goal of the Department of Molecular Biosciences is to study fundamental biological processes and their perturbations by mutations, nutrition, drugs and xenobiotics and the application […]