Chapter 14
Ecotoxicological Risk Assessment of E-waste Pollution

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Abstract Electronics have unique characteristics and can be a source of significant environmental degradation, making these devices problematic toxic waste. Over the past few decades, e-waste management has not been well organized, meaning that the human population and the environment have suffered the consequences of improper treatment of e-waste. For instance, much ends up in landfill, where it can cause leaching of hazardous materials, mercury vaporization, and fires, which lead to atmospheric pollution and toxic ash residues. This study reviews recent reports on human exposure to e-waste, with particular focus on exposure routes and toxicities of humans. Specific e-associated chemical elements and compounds exist in the form of components of the equipment, target. Pieces of evidence that associate e-waste exposure with human health effects are assessed. The role of toxic heavy metals (lead, cadmium, chromium, and mercury) and organic pollutants (polybrominated diphenyl ethers (PBDEs), polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), polybrominated biphenyls (PBBs), polyhalogenated aromatic hydrocarbons (PHAHs), and biphenyl A (BPA)) on human health is also briefly discussed.

Keywords Toxic substances · Electronic waste · Environmental pollution · Toxicological effects

14.1 Introduction: Terminology and Definitions

The constant advancement of society is conditioned by the rapid development of modern technologies leading to the increasing production and use of various electrical and electronic devices and equipment without which everyday life cannot be imagined. As electrical and electronic equipment (EE equipment) and appliances can

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be defined all products that are completely dependent on electricity or electromagnetic fields for their proper operation. Furthermore, in EE equipment can be also included equipment for production, transmission, and measurement of current, or equipment for measuring the strength of electromagnetic fields. This equipment is intended for use at a voltage not higher than 1000 V for alternating current and 1500 V for direct current (Widmera et al. 2005; UN Environment Programme 2007; Robinson 2009). Electrical and electronic waste (EE waste) is waste electrical and electronic equipment including the assemblies and components that occur in the economy (industry, processing, etc.), electronic waste from households, that is, waste electrical and electronic equipment incurred in households or in production/service activities when by type and quantity is similar to EE household waste (UN Environment Programme 2007; Robinson 2009).

Electrical and electronic waste has the characteristics of hazardous waste, and, according to the Law on Waste Management, it cannot be mixed with other types of waste. Electrical and electronic waste contains toxic and very often carcinogenic substances, and therefore it is very dangerous for human health, the environment, and our planet. Exposure to e-waste might occur directly via recycling or indirectly via ecological exposure (Frazzoli et al. 2010). Huge amounts of electronic waste are transferred to less developed countries at certain dump sites or are subjected for the recycling processes (Frazzoli et al. 2010; Sthiannopkao and Wong 2013; Julander et al. 2014). Therefore, it is necessary for EE to handle the waste properly and that its recycling procedure is in accordance with the prescribed legal provisions. The goal of electrical and electronic waste management is to establish a system for separate collection of electrical and electronic waste. It needs to be classified on the basis of the categories of EE waste for its further use, care and protection of the environment and the health of the citizens.

14.2 Origin, Processes, and Circumstances of Environmental Risks Related to E-waste

The electronic waste category includes all types of computers and computer equipment (keyboards, mice), monitors, printers, cartridges, toners, scanners, mobile phones, cameras, TVs, video, and audio devices. For electrical waste are considered all larger devices, i.e., refrigerators, stoves, washing machines and dryers, boilers, air conditioners, and other household appliances. This category also includes assembles and device component parts that are accessible in the industry. Electrical and electronic equipment from which natural and legal persons want to be released because it is dysfunctional or obsolete is considered waste and should be handed over to an authorized recycler.

Due to the toxicity of the components in the electronic equipment, they should be treated very carefully. Therefore, it is extremely important how to deal with it. Most electronic and electrical devices contain dangerous substances such as mercury, freon, and arsenic that are harmful to the environment (water, soil, air) that directly