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Nefarious Effect of E-Waste on Environment & Health Hazardous

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Abstract: ***Rapid changes in technology, changes in media, falling prices, and obsolescence have resulted in a fast-growing surplus of electronic waste around the globe. Uncontrolled disposal and recycling activities generate and release high toxic metals & also release high concentrations of different types of flame retardants such as Poly Brominated Diphenyl Ethers (PBDEs), Poly-Chlorinated Biphenyls (PCBs) and Organo Chlorine Pesticides (OCPs). Electronic wastes are environmentally hazardous, also contain substantial amount of metal value, including precious metals and are making them dangerous and hazardous human health too.***

Keywords: E-waste, health, management, effect, hazardous

1. Introduction

"..includes garbage, refuse, sludge, rubbish, tailings, debris, litter and other discarded materials resulting from residential, commercial, institutional and industrial activities which are commonly accepted at a municipal solid waste management facility, but excludes wastes from industrial activities regulated by an approval issued under the Nova Scotia Environment Act" (SWRMR, 1996).The increasingly rapid evolution of electronic technology, quantities of electrical and electronic equipment (EEE) in use and the rate of replacement of even functioning EEE are increasing , has compounded the e-waste problem (Otsuka et al. 2012). "any appliance using an electric power supply that has reached its end-of-life"(UNEP 2007). In the absence of proper collection and disposal systems, awareness, and proper regulations, the problem is rather more acute in developing nations. RSA 2008 Baseline assessment: Combined ICT, Consumer Electronics and White Goods estimated between 1-2 million tons entering waste stream in 5-10 years (10-20% annual growth rate. Research and development work on their recycling has led to several technological options. However, a close investigation of the options reveals that there is no universally acceptable model for management of e-waste and they are still evolving. According to the United Nations (UN), the initiative to estimate e-waste production, the world produced approximately 50 million tons of e-waste in 2012, on an average of 15 lbs. per person across the globe. Currently , most consumer electronic devices (CEDs) end up in landfill site s without proper treatment because there is no segregation mechanism. Thus, more than 90% of e-waste was land filled while in other countries, a large fraction of e-waste from households ends up in waste incinerators.

Components of E-Waste:

- Large house hold appliances
- IT & telecom equipments
- Consumer equipments

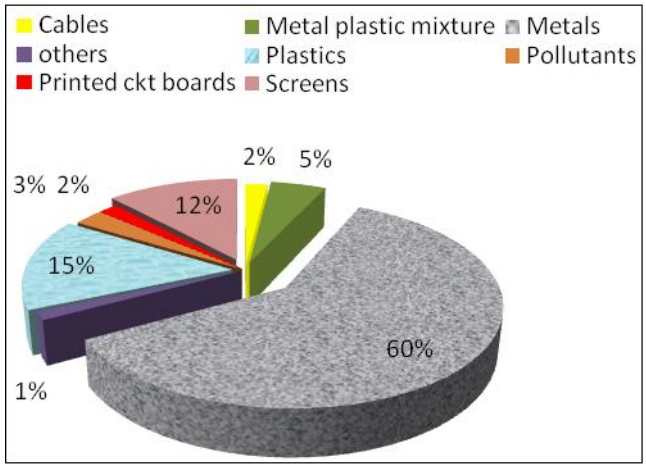

Figure 1: Material fraction in e-waste

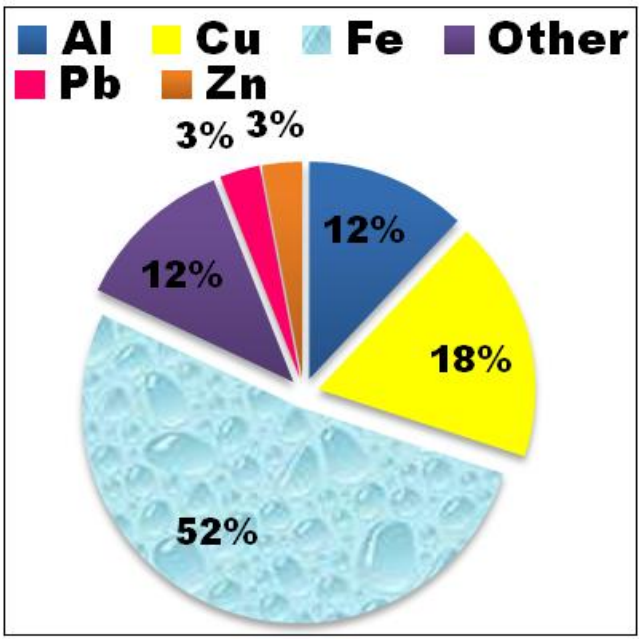

Figure 2: Material composition of a typical computer

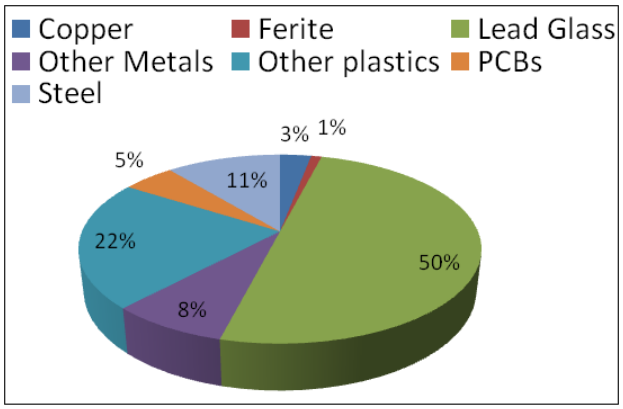

Figure 3: Material composition of a typical TV

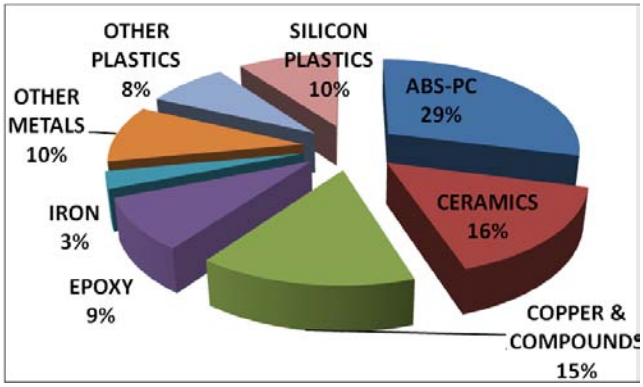

Figure 4: Material composition of a typical Mobile phone

2. Impact on environment & Health

Disposal of e-wastes that are landfilled produces contaminated leachates which eventually pollute the groundwater. Acids and sludge obtained from melting computer chips, if disposed on the ground causes acidification of soil.

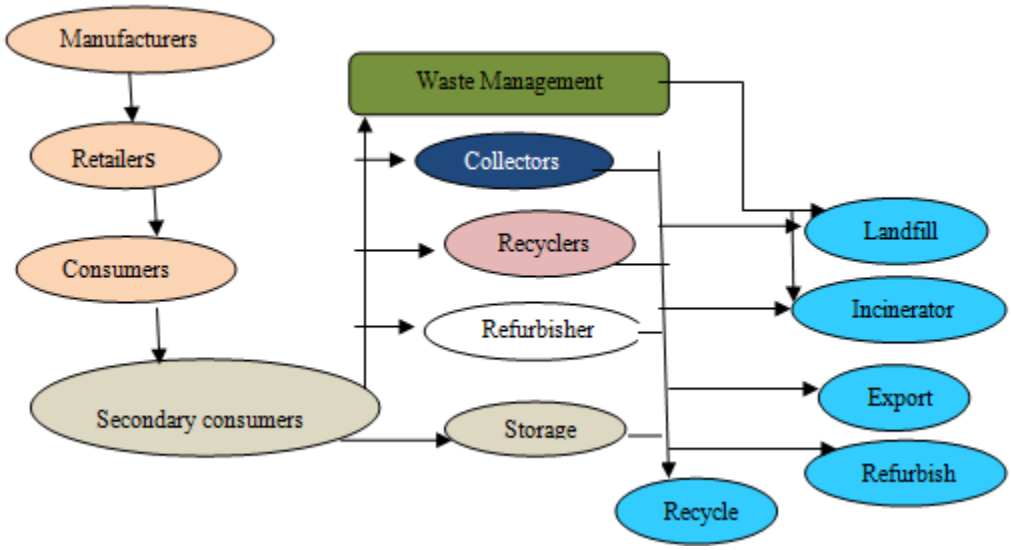

Figure 5: Life cycle of Electronics

Table 1: Pollutants or toxins in e-waste & their occurrence

Pollutants	*Occurrence*
Arsenic	Semiconductors, diodes, microwaves, LEDs
Barium	Electron tube, filler for plastic and rubber, lubricant additives
Beryllium	Motherboards, finger clips
Brominated flame Retardants(BFRs)	proofing agent Casing, circuit boards (plastic), cables and PVC cables
Cadmium	Batteries, pigments, solder, alloys, circuit boards, computer batteries, monitor cathode ray tubes (CRTs), surface mounted device (SMD), infa-red detectors
Cobalt	Insulators
Copper	Conducted in cables, copper ribbons, coils, circuitry, pigments
Hexavalent Chromium/ Chromium VI	man-made: widely used in many different industries, corrosion protector of untreated and galvanized steel plates and as a decorative or hardener for steel housings
Lithium	Mobile telephones, photographic equipment, video equipment (batteries)
Mercury	Components in copper machines and steam irons; batteries in clocks and pocket calculators, relays, switches, LCDs, sensors, medical equipments, mobile phones
Nickel	Alloys, batteries, relays, semiconductors, pigments
Lead	rechargeable batteries, solar, transistors, lithium batteries,
Phosphor	coat on the interior of the CRT faceplate
PCBs (polychlorinated biphenyls)	Transformers, capacitors, softening agents for paint, glue, plastic
PVC (polyvinyl chloride)	stabilizers, lasers, LEDs, thermoelectric elements, connectors, cables, computer housing
Selenium	Photoelectric cells, pigments, photocopiers, fax machines
Silver	Capacitors, switches(contacts), batteries, resistors

Lead:- Lead is a naturally-occurring element that can be harmful to humans when ingested or inhaled, particularly to children under the age of six. Lead causes damage to the central and peripheral neurological systems, blood systems, kidney and human reproductive system. It also affects the endocrine system, and impedes brain development among children. Lead tends to accumulate in the environment and has high acute and chronic effects on plants, animals and micro organisms (Metcalf & Eddy,2003).

Cadmium: Cadmium can be bio-accumulate in the environment and is extremely toxic to human, in particular adversely affecting kidneys and bones, especially the liver, kidneys pancreas, thyroid (Metcalf & Eddy, 2003, Basel Action Network, 2002), relatively long time from 20 to 30 years and at high doses, is also known to produce effects on the respiratory system and has been associated with bone disease.

Mercury: Mercury can cause damage to central nervous system. It is estimated that 22 % of the yearly world consumption of mercury is used in electrical and electronic When inorganic mercury spreads out in water then it bio-accumulates in living organisms and concentrates through the food chain, particularly via fish (Basel Action Network, 2002). Elemental and methyl mercury are toxic to the central and peripheral nervous systems. Mercury can cause damage to the breast milk. The inhalation of mercury vapour can produce harmful effects on the nervous, digestive and immune systems, lungs and kidneys, and may be fatal. The inorganic salts of mercury are corrosive to the skin, eyes. Neurological and behavioral disorders may be observed after inhalation, ingestion or dermal exposure of different mercury compounds. Symptoms include tremors, insomnia, memory loss, neuromuscular effects, headaches and cognitive and motor dysfunction.

Lithium: It can pass into breast milk and may harm a nursing baby.

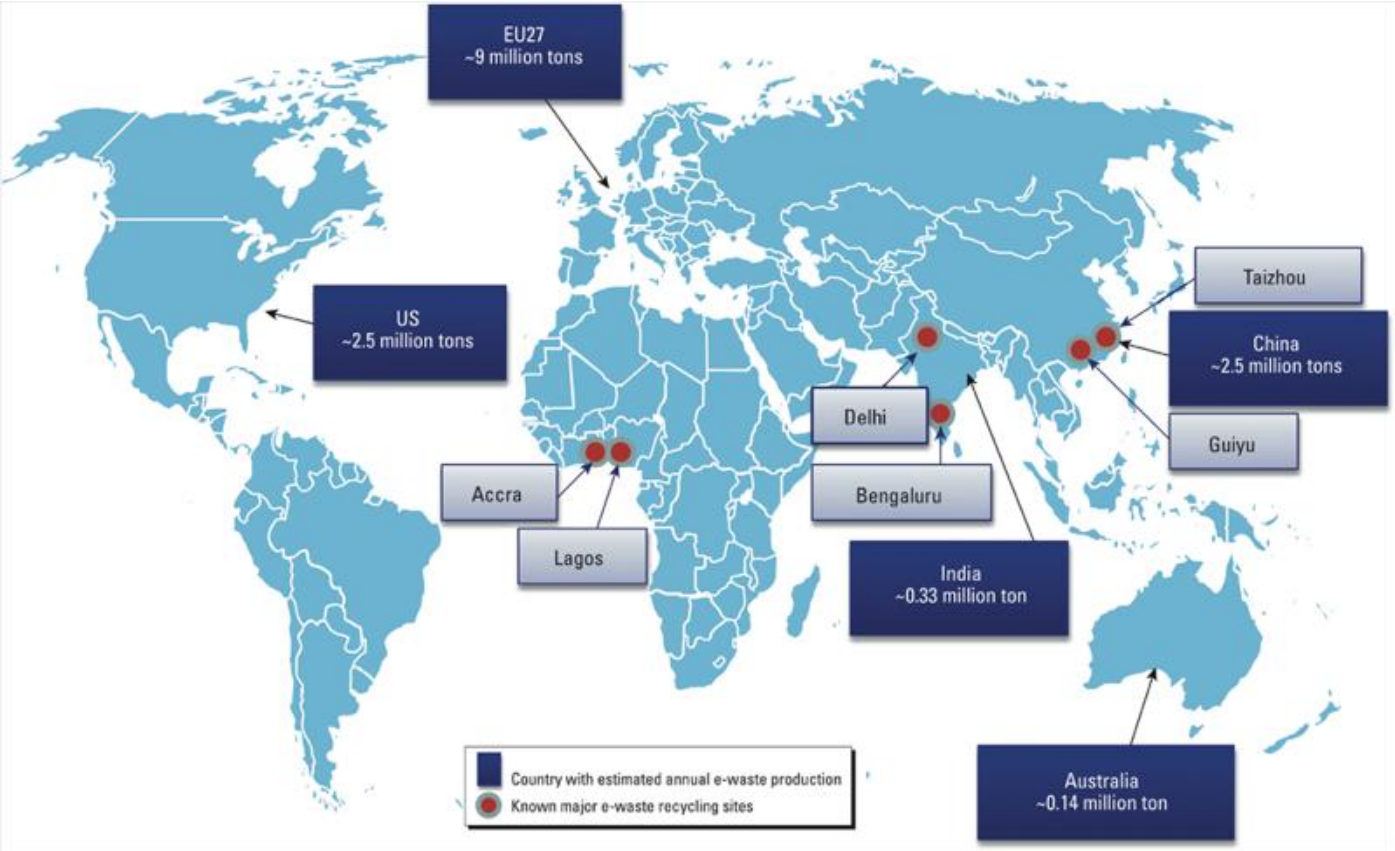

Fig:6 Estimated annual production of e-waste and major recycling sites. Estimates are from Robinson (2009), Davis and Herat (2010), and Cobbing (2008) and may not reflect current production. In addition, the estimates are not complete for many regions, for example, Japan, Russia, and Canada. The number of recycling sites is by no means complete but may represent major processing regions of e-waste

Hexavalent Chromium/Chromium VI:-
It is a toxic form of the chromium element cause damage to DNA & in the environment. Long term effects are skin sensitization and kidney damage(Metcalf & Eddy, 2003).It can also cause lung cancer, irritation or damage to the nose, throat,and lung (respiratory tract), irritation or damage to the eyes etc.

Table 2: Characteristics of known and suspected neurotoxicants in e-waste and from its informal recycling processes

Toxicant	Potentially affected neuropsychological functions in children	Transplacental exposure	Lactational exposure	Exposure route of childhood
Pb	Cognition (verbal and performance), fine and gross motor skill,s memory, attention, executive function, hyperactivity, academic achievement, delinquent behaviour	Yes	Yes	Air, dust, water, soil, leaded paint, leaded gasoline(if not banned)
Hg	Cognition, language, motor function, attention	Yes	Yes	Air seafood, Hg vapour
Cd	Cognition	Limited	Yes	Air, dust, rice, vegetables, environmental tobacco smoke
Cr	Motor function (animal study only)	Yes	Yes	Air,dust, water
PBDEs	Cognition	Yes	Yes	Air, dust,food
PCBs	Cognition, visual-spatial function, memory, attention, impulse control, executive function, motor, behaviour	Yes	Yes	Air, dust, seafood
PCDD/ PCDFs	Cognition	Yes	Yes	Air,dust,soil,food
PAHs	Cognition	Yes	Yes	Air, dust,soil,food

Plastics (including PVC): Dioxins are released when PVC is burned (Basel Action Network, 2002) & thus harmful effects on human reproductive and immune systems. The largest volume of plastics (26%) used in electronics has been PVC.

Brominated flame retardants (BFRs): These do not decompose easily in the environment, show bioaccumulation and long term exposure can cause impaired memory function and learning. Concerns are raised considering their potential to toxicity (Basel Action Network, 2002). Pregnant women exposed to brominated flame retardants have been shown

to give birth to babies with behavioral problems as it interferes with estrogen and thyroid functioning.

Barium: It causes brain swelling, muscle weakness, damage to the heart, liver, and spleen(Basel Action Network, 2002).

Beryllium: Exposure to beryllium can cause lung cancer, skin disease

Phosphor: It contains heavy metals, such as cadmium, and other rare earth metals, for example, zinc, vanadium as additives. These metals and their compounds are very toxic. This is a serious hazard posed for those who dismantle CRTs by hand.

Regulations on e-waste

In India

The policy level initiatives regarding e-waste in India regarding E-waste, some of which is furnished below-

The Hazardous Wastes (Management and Handling) Amendment Rules, 2003

Guidelines for Environmentally Sound Management of E-waste, 2008

The e-waste (Management and Handling) Rules, 2011

In other countries

European Directive on the Restriction of the Use of certain Hazardous Substances (RoHS) in electrical and Electronic Equipment, 2006

European Directive on the Waste Electrical and Electronic Equipment (WEEE), 2003.

The Electronic Waste Recycling Act of 2003, California, USA

3. Conclusion

A strategy of "Reduce, Reuse, Recycle" should to be adopted for e-waste disposal. Reduce the generation of e-waste through smart procurement and good maintenance. Reuse the electronic equipment by donating or selling it to someone who can still use it. Recycle those components that cannot be repaired. Use only authorized recyclers for disposing the e-waste products.

Government take responsibility to encourage research into environmental monitoring and the regulation of hazardous waste-disposal; collect toxicity and potential harmful effects of the materials involved manufacturers, processors and importers ; provide e-waste regulation & management. Law should empower the agency to control & administrative procedures for hazardous waste management, disposal should be revamped. Government should support NGOs and other organizations for solving the e-waste problems & should explore opportunities to partner with manufacturers and retailers to provide recycling services.

Generators of wastes should take responsibility to determine the output characteristics of wastes and if hazardous, should provide management options. All personnel involved in handling e-waste in industries including those at the policy, management, control and operational levels, should be properly qualified and trained. Companies can adopt their own policies while handling e-wastes. Some are given below:

Encourage / promote / require green procurement for corporate buyers

Use label materials to assist in recycling (particularly plastics)

Create computer components and peripherals of biodegradable materials.

Utilize technology sharing particularly for manufacturing and de manufacturing

Citizens should alert while buying electronic products which are made with fewer toxic constituents, use recycled content, are energy efficient, are designed for easy upgrading or disassembly , utilize minimal packaging, offer leasing or take back options. Care should also be taken while donating such items. By donating used electronics, schools, non-profit organizations, and lower-income families can afford to use equipment that they otherwise could not afford. E-wastes should never be disposed with garbage and other household wastes.

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