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GROUNDWATER CONTAMINATION DUE TO UNCONTROLLED DISPOSAL OF E-WASTE IN SOME REGIONS OF WESTERN UP

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ABSTRACT
The electronic waste is a heterogeneous mixture of metals, plastics, glass, computers, mobiles and telephones. The Cathode ray tube in computer monitors and Television contain 0.4 & 1 kg of heavy metals respectively. These metals are mainly Lead and Cadmium. The dismantling and disposal of electronic waste in developing countries is major concern because of its impact on the environment and risk to human health. Uncontrolled disposal of e-waste generate and release high toxic metals such as Hg, Pb, Cd, and chromium and high concentrations of different types of flame retardants such as *Poly Brominated Diphenyl Ethers* (PBDEs), *Organo-Chlorine Pesticides* (OCPs). Heavy metal concentration in the groundwater of western Uttar Pradesh was monitored to determine their status in dismantling areas. Burning sites probably contains invaluable e-waste and abandoned sites formely involved in informal recycling activities are the new sources of ground water based environmental pollution in some districts of western UP. Most of the e-waste has their self life, after which they cannot be reused. Hence, it is essential either to recycle them or their disposal with suitable precautions.

KEYWORDS: Heavy metal, e-waste, environmental hazards, western Uttar Pradesh.

INTRODUCTION
Groundwater is one of the most important and fundamental natural resources, critical to human survival. The human health and environment are directly affected by the exposure of heavy metals. Rapid growth in technologies and domestic generations are responsible to grow the problem of electronic waste in India and its states. The air, water, soil, sediment, crops and wildlife in India and its states have been found to be highly contaminated with heavy metals. Personal computers contain certain components, which are highly toxic, such as chlorinated and brominated substances, toxic metals, biologically active materials, acid, and plastics additives posing an environment and health threat. Circuit boards in computer contain heavy metals, plastics and polyvinyl chloride coated copper cables. Basal Action Network (BAN) estimates that the 500 million computer in the world contain 2.87 billion kg of plastics, 716.7 million kg of Lead, 286 700 kg of Mercury. An average 14-inch monitor uses a tube that contains an estimated 2.5 to 4.0 kg of lead. (Jian, 2009).

Developed countries like USA, Europe and Australia are the major producers of e-waste, which is very often exported to developing countries like India and China, where labour is cheap. Here, workers use primitive recycling techniques such as acid leaching and cable burning to receive gold, silver, copper and valuable metals. Side by side incineration of e-waste can emit toxic fumes and gases, thereby polluting the surrounding air. Improperly monitored landfills may cause significant environmental hazards. Metals like Mercury and Cadmium leach out when certain electronic devices, such as circuit breakers are destroyed. The same is true for polychlorinated biphenyls from condenser (UNEP, 2010).

A study in Queensland University, Australia found a possible association between e-waste exposure and thyroid dysfunctions, adverse birth outcome, behavioral changes, decreased lung function and adverse change that can be seen at the cellular level (Avakian, 2014). Children are especially vulnerable to the effects of e-waste. Areas prone to illegal e-waste recycling are facing severe water shortages due to the contamination of water resources. Acidification of water and soil is a major outcome of melting the electronic chips. More than 1000 substances are present in e-waste which affects environment and Human health, some of which are summarized in **Table-1.**

Table-1: Effect of various components of e-waste on environment and human

SN	Components	Effects
1	Cadmium	Accumulate in Kidney ,Liver and Cause neural damage
2	Mercury	Disorder of respiratory systems
3	Brominated flame Retardants	Disturbs to Endocrine system or chemical co-ordination.
4	CFC & HFC	Damage to the ozone

In India ten states generates 70% of e-waste. Western Uttar Pradesh is a rich and prosperous belt of India. Here, business sector is more responsible to generate the e-waste than the other agencies. About 25 tons per year of computer waste comes from retailers and manufacturers, more than 40% of which is generated from six cities. In western U.P. no large scale organized e-waste recycling facility available, the rag pickers (also known as kabadiwala) collects all kind of e-waste and either sell them to scrap dealers or dismantle them illogically leading to soil and water contamination.

MATERIALS AND METHODS

A survey of contaminant level in western UP was conducted in October in 2015. Six districts were selected for this study from western UP *viz.* Saharanpur, Meerut, Ghaziabad, Bareilly, Moradabad and Rampur. Their details are summarized in **Table-2**. These sites include present functional activity of e-waste processing workshops, municipal solid waste (MSW) open burning sites and abandoned buildings.

Table-2: Details of sample collection sites in Western Uttar Pradesh

Samples	Location	Remarks
S-1	Paddy and Wheat fields groundwater	Saharanpur
S-2	Street in residential area	All selected districts
S-3	Adjacent street	All selected Districts
S-4	Groundwater from the Abandoned workshops	Banned by U.P. government
S-5	Farming areas near MSW open burning sites	-
S-6	Rivers closed to storage of E-waste	-

Water samples from the tap and hand-pumps of different boring depths (30-150 feet below ground level) were collected in prewashed (with detergent followed by nitric acid and doubly di-ionised distilled water) double capped glass bottles. Before collection, the water was allowed to run for at least 05 minutes. (Reimann *et.al.*1996) The samples were acidified to 1% with Nitric acid and then stored in 100 ml double capped glass bottles prewashed in previous manner. (Gebrekiden and Samuel, 2011).

Determination of Heavy metal concentration in collected samples was done with the help of (AAS) Atomic Absorption spectroscopy. (Alcantra *etal.*, 2004 and Mohmmad *etal.*1992).

RESULT AND DISCUSSION

The results of AAS analysis of water samples collected from different sites are shown in table-3.

Table-3: Cadmium concentration in samples collected from different sites.

SN	Sample No.	Cadmium Concentration (mg/L)
1	S-1	0.42
2	S-2	0.18
3	S-3	0.10
4	S-4	1.10
5	S-5	2.80
6	S-6	2.25

The resulting cadmium concentration in drinking water was compared with International standards recommended by WHO (World Health Organization) and USEPA (United State Environmental Protection Agency's). The maximum acceptable values (MAV) for Cadmium in drinking water according to WHO (2008) and USEPA (2002) is just 0.005 mg/L. The results indicate that the groundwater has been seriously contaminated with cadmium.

Global e-waste disposal has crossed all the limits. Although recycling is another aspect of positive hope but it is not enough to compensate with huge amount of disposal. Public unawareness also plays an important role in this scenario. Due to very stringent environmental standard, the cost of collection, preprocessing, recycling and disposal are pretty high in developed countries. Thus India, China and few African countries have become dumping sites to the first world countries. Data statics present in Table-4 clears the global picture of e-waste.

Table-4: Global WEEE (million tons) production, disposal, Recycling and import/Export.

Country/ Region	Annual household production	Land filling storage	Domestic recycling	Annual export	Annual import
USA	6.6	5.2	0.13	1.3	
EU-2	7.0	1.6	3.53	1.9	
Japan	3.1	0.6	1.94	0.62	
China	3.1	3.6	1.5		2.0
India	0.36	0.85	0.36		0.85
West Africa	0.05	0.45	0.17		0.57
Total	20.21	12.3	7.56	3.85	3.42

There are many countries that have already started the 'take back' system for electronic products and they also have dedicated laws on E-waste management. USEPA has started action plan to address the various issue related to electronic waste. Two very important frameworks for protecting environment from E-waste have been put forward by European Union i.e. WEEE Directives and Restriction of use of certain Hazardous Substances (RoHS), which are also implemented by other countries. According to EU directives (2003), it's mandatory for all 27 countries of European Union to recycle their e-waste. Basel Convention is also nice step taken by UNEP to control the international trading of hazardous waste and India is also signatory to this (Joshi, 2008 and Khetriwal *et.al.*, 2005).

India occupies last but one place in this table, but here illegal disposal is at its peak. Recycling is far to reach equal to the generated amount. Data statics present in Table-5 clears the picture of e-waste disposal and recycling in India.

Table5: Recycling Vs generation of e-waste in India

e-waste quantities	Weight (million tons)
Imported	332979
Domestically generated	50000
Total	382979
WEEE available for recycling	144143
WEEE actually recycled	19000
WEEE quantity targeted to recycle	467098

Present scenario is fully occupied by electronic item, their selling and buying is the largest business of today. No field of life is complete without implication of electronic devices, resulting in a lot of scrap and e-waste. Logical disposal of these e-scraps involves their separation, labeling and recycling, which is not done actually. Table-6 throws light on e-waste scrap percentage contribution of different life sectors showing the intensity of problem.

Table-6: Various categories of waste Electrical and Electronic Equipment.

SN	Category	Label	% of contribution
1	Large household appliances	Large HH	42.1
2	Small household appliances	Small HH	47
3	Consumer equipments	ICT	33.9
4	Lighting equipments	CE	13.7
5	Electric and electronic tools	Lighting	14
6	Toys and leisure and sport equipment	E & E tools	14
7	Medical devices	TOVS	0.2
8	Monitoring and control measurement	Medical equipment	19
9	Automatic dispensers	M&C	0.1
10	Automatic dispensers	Dispensors	0.7

Major sector is covered by household appliances and consumer equipments denying the ignorance of disposal. A survey of last year in Rampur, the place where study was conducted has been presented in table-7 shows how the sale of these appliances goes up high leading to concern about their safe and eco-healthy disposal.

Table-7: Scarp numbers of five Major Electronic items in year 2015 at Rampur.

Month	Refrigerators	Air Conditioners	Washing machines	Televisions	Computers	Total
JAN	05	01	05	15	20	46
FEB	03	00	07	18	22	50
MAR	01	02	05	17	18	43
APR	05	04	03	10	08	30
MAY	10	06	05	25	18	64
JUNE	12	05	16	10	20	63
JULY	10	14	20	05	18	67
AUG	03	00	00	03	07	13
SEP	01	02	09	11	01	24
OCT	00	01	02	03	06	12
NOV	01	04	07	06	05	23
DEC	00	01	10	22	08	41

Dismantling of e-waste illogically is followed by either open air burning or dissolving by acid etc. to get valuable parts of it. It has been found that Cadmium ions are leached from disposed off e-waste materials like cathode ray tube and electronic chips etc. Significant amount of Lead and Cadmium ions from broken cone glass of cathode ray tubes and other electronics get mixed with water and turning it to acidic, which is a common occurrence in landfills. The toxic fallout from open air burning affects the local environment and broader Global air currents, depositing highly toxic byproducts in many places throughout the world (Sivakumar, 2011 and Ramachandra & Sarah, 2004).

The responsibilities of the government (should be friendly with environment) and include Govt. should setup regulatory agencies in each districts, responsible for providing an adequate system of Laws, control and administrative procedures for hazardous waste management. The responsibilities of industries include that use label materials to assist in recycling, create computer components and peripherals of biodegradable materials and look at green packing options. The companies should adopt waste minimization techniques which will make a significant reduction in the quantity of E-waste generated and thereby lessening the impact on the environment.

A number of policies are made to check illegal and illogical disposal of e-waste. Although government is trying in many ways to control over the waste disposal sites, still there are many sites which were closed earlier because of informal and non-standard processing, subsequently abandoned are contaminated with heavy metal dust. Several sites where the open burning of MSW was present also contaminated with contamination of heavy metal because this waste also contain some e-waste material. Contamination from particulate and gaseous emission containing heavy metal, dioxins, acid and other compounds from such incinerators as well as fly ash are of great concern (Lisk, 1998). The low combustion temperature and locally oxygen-starred conditions associated with open burning may result in incomplete combustion and much more increased pollutant emission (Lemieux *et.al.*, 2000).

In India, more than ninety percent of e-waste is consumed by the informal sectors. The rag pickers are dealing with the electronic items in the form of household or an office is mined unscrupulously for metal and the E-waste is mostly handled by unskilled workers and they do not take proper safety measures. So, recycling and disposal is not properly done due to lack of appropriate technology hence today is urgent need of implementation of proper e-waste management system in western U.P. through research and education at all levels and creating awareness among the e-waste generation sectors at present is the important task now.

CONCLUSION

The present study surveyed the status of Heavy metals contamination in ground water in some districts of western U.P. This confers that e-waste management institutional infrastructures should be established at all levels for e-waste collection, transportation, treatment and storage with recovery and disposal. At present most of the developing countries are trying to adopt the e-waste management system that will help collection right upto the extraction and disposal of material. The manufacturers should take a step to reduce the e-waste in their environment, when they start the preparation of their product manufacturing stage i.e. from the selection of raw material. It is important to know how the community can play a role in reducing their exposures. The main role of society includes, E-waste should never be disposed with garbage and other household wastes. It should be segregated at the site and sold or donated to various organizations. Proper e-waste management from efficient sourcing and collection right upto extraction and disposal of materials ensure that this huge pile of junk may turn into a lucrative business opportunity.

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