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Assessment of Effect on Environment due to Electronic Waste in Dhaka City

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ABSTRACT: The changing lifestyle of people coupled with urbanization, rapid technological progress and decreasing lifespan of a single electronic device, has led to increasing rates of consumption of electronic products. This has made electronic waste a burning issue of environment and health concern. The study has been conducted to effectively bridge the gaps in understanding the knowledge of electronic scraps and its impact on environment. It involves the study of the market, nature and present practice of reprocessing of e-waste components, awareness level of people involved and experimental result of heavy metal content of soil and water sample of some e-waste hotspots. Chankherpul is the largest secondary e-waste accumulation centres in the city. Besides, e-wastes are also accumulated and dismantled in Elephant Road, Stadium market, Kodomtoli, Jinjira, Kamrangi chor, Segun Bagicha and Notun Bazar. Most of the elements of e-waste have its own recycling process. Test results of heavy metal content of water samples collected from the water body near to the e-waste hotspots (Chankherpul, Islambag and Waizghat) shows existence of large amount of Iron, Lead, Cadmium, Copper and Chromium. Test results on soil samples also indicate significant existence of heavy metal content. Proper attention needs to be paid to the informal e-waste dismantling sector so that in future it does not become a threat to the country. In this regard proper quantification of e-waste, advance and sophisticated waste collection and disposal system, logistics and legal frame work and a technical solution need to be developed and implemented.

KEYWORDS: electronic waste; recycle; management; environment; pollution.

I. INTRODUCTION

Just below the glamorous surface of the benefits and wealth created by the technology revolutions looms a darker reality. Electronics manufacturing is the world's largest and most rapidly expanding industry. This 21st century is called 'The information age or digital age'. It has improved peoples life in many ways and electronic products have become part and parcel of our everyday life. Growing dependence on electronic products has given rise to a new environmental challenge - electronic waste or e-waste. E-waste is a collective terminology for the entire stream of old, end of life electronic product [1]. It is one of the fast growing waste streams in the industrial world. Improper dismantling and disposal of waste electronic products releases toxic and hazardous material such as lead, mercury, cadmium, brominated flame retardants and POPs (persistent organic pollutants) into the environment that poses serious occupational and environmental threats [2]. Every year about 20 to 50 million tons of e-waste is generated worldwide [3]. Due to high recycling cost and negative environmental impact, most of the e-waste generated in the developed countries is illegally sent to the developing and underdeveloped countries where labor cost for dismantling of e-waste is very low and where environmental pollution is not a big concern [4].

Bangladesh is a developing country with a population of 14.97 crores with a growth rate of 1.34 % [5]. Country's expenditure on information and communication technology is rapidly increasing. Expenditure on information, communication and technology (ICT) (% of GDP) in Bangladesh was reported at 9.04 % in 2008, according to World Bank, whereas in 2004 it was 2.41 % [6]. The Mobile cellular subscriptions (per 100 people) in Bangladesh was last reported at 46.17 in 2010, according to a World Bank report published in 2012 [6]. But in 2004 it was 2.01 per 100 people. About 3.5 million personal computer were recorded in 2006 [7] whereas in 2004 it was 1.7 million. About 41-43% of the total population enjoyed electricity supply in 2009 which has increased to about 60% after 2012 [7,8].

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Rising income and standard of living, falling prices of electronic products are enabling more people to afford more and more electronic products. Moreover, rapid technological progress resulted not only in a multitude of new electronic products but also reduced their life span. Now a day products become obsolete faster than before, thus increasing e-waste [9].

The highly toxic chemicals found in the different components of electronic products can contaminate soil, groundwater and air, as well as affect the workers of the unit and the community living around it [10]. Moreover, the workers in e-waste recycling operations may face dangerous working conditions where health and environmental conditions are compromised. Hence there is a clear reason to be concerned about the processes and the technology in practice and the existing disposal practices of e- waste in Bangladesh. An assessment of the above is very important as only then can interventions be suggested to check the polluting systems of recycling and give viable options for better management of e- waste.

II. RELATED WORK

World's production of e waste was estimated at 20 to 50 million tonnes per year in 2006 [11], which is 1-3% of the global municipal solid waste production of 1636 million tonnes per year [12]. Several studies have already been conducted in estimating e waste and its potential effect on human health as well as on environment due to inappropriate and unsafe management practices in disposal and recycling of waste electrical and electronic equipments.

China, being the world's leading manufacturing country has also become the largest dumping ground for e-waste, resulting in serious pollution of heavy metal. In a study, about 0.4 mg/l Pb in a river water downstream of a recycling plant in Guiyu, China [13] was found which is eight times higher than the local drinking water standard (0.05 mg/l). Elevated concentration of Cd, Cu, Cr, Ag are found in the nearby Lianjiang river [14].

Being a highly populous country, a huge amount of e waste is generated in India and because of cheap labor cost foreign e-waste is exported to India for dumping, dismantling and recycling. Soil at an e-waste recycling slum in Bangalore contained up to 39 mg/kg Cd and 2850 mg/kg Pb [15]. A similar study shows that exposure to e-waste recycling is associated with the following health outcome: mal-functioning of thyroid gland and lung, adverse birth outcome, deterioration of mental health, changes to cell functioning [16].

III. OBJECTIVES OF THIS STUDY

The study has been conducted to identify the e-waste hotspots in Dhaka city on the basis of direct interview with the people involved in collection and further distribution of end of life electronic equipment or their damaged part from several major outlets of Dhaka city, assessing the environmental condition of the hotspots based on questionnaire survey and experimental result of soil and water sample of three e-waste hotspots on some selected environmental parameters such as Lead, Chromium, Cadmium, Copper and Iron, understanding the awareness level of the actors involved in the management of domestic e-waste mostly for home appliances.

E-waste management system is new in Bangladesh. Though the volume of e-waste material is increasing due to increasing rate of consumption of electronic products, its harmful effects on environment and on public health are not well known by the people and the necessity of recycling some these wastes has not even been felt both in private and Government level. There is no industry that follows the international standards to recycle e-waste and dispose harmful ingredients properly.

IV. STUDY AREA

An informal sector for dismantling in house e-waste has already been established in Dhaka city. In some areas of Dhaka specially Islambag, Chadnighat, Waizghat, Urdhuroad, Mredhabari Chankharpul, Chakbazar, Nawabpur, Dholaikhal, Notunbazar, Dholai-par, Jinjira and Kamrangi-chor hundreds of people are dismantling e-waste in a very unhygienic manner, sometimes burning them in open fire for material recovery thus polluting air and soil, sometimes washing them in nearby waterways and polluting water. Table 1 and Figure 1 shows the location map of the study area.

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Table 1: Study area

Area	Related information
Chankherpul, Nimtoli	Source, accumulation place, price and amount of e-waste
Kamrangi chor	Source, accumulation place, price and amount of e-waste
Kodomtoli, Jinjira	Repairing shop (TV, Refrigerator)
Islambag	Plastic, PCB and cable cover (PVC)
Mridhabari, Matuail	Glass
Dholai khal, Waseghat	Battery
Bacharam dauri, Armanitola	Copper wire
Elephant road	Sales and repair shop of electronic products
Stadium market	Sales center of new electronic products (TV, Refrigerator) as
Segunbagicha	Repairing shop (TV, Refrigerator)
BCS computer city, IDB bhobon	Sales center of new electronic products(computer)

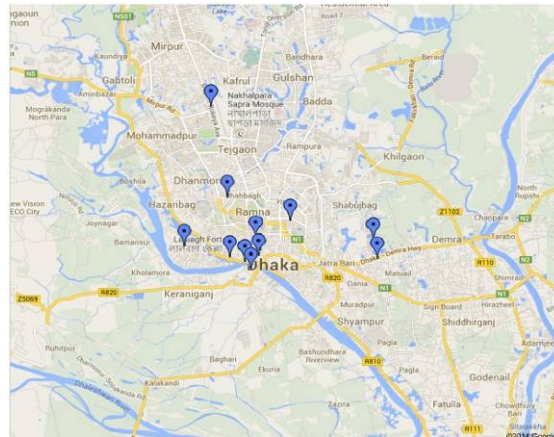


Figure 1: Map location of e-waste hotspots

V. RESEARCH METHODOLOGY

The study is based on direct interview with the e-waste dismantling shop owners and the involved workers to determine the present environmental condition, health & hygiene safety issues as well as awareness level of people involved in the current management of electronic waste. For assessment of water quality for some environmental parameters such as Lead, Chromium, Cadmium, Copper and Iron, surface water is collected in 2008, 2009, 2013 and 2014 during the dry season specifically from nearby water bodies of e-waste dismantling sectors (Water from Buriganga River near Waizghat and Islambag and storm sewer for Chankherpul). Soil sample is also collected from the hotspots in 2008, 2009, 2013 and 2014 for assessing the soil quality for the same parameters.

VI. CHARACTERISTICS OF E-WASTE HOT SPOTS

Nimtoli, Chankherpul, Islambag, Stadium market, Kamragichor, Jinjira are the major sectors that directly deal with e-waste in Dhaka city. Chankherpul is one of the largest sectors where huge amount of e-waste is dismantled everyday. Few amount of e-wastes are also dismantled in Segunbagicha and Notunbazar. Besides those Islambag, Becharamdauri, Mredhabari deals with specific items such as plastic, copper and glass respectively. Dismantling of e-waste is also done in the periphery of Dhaka city such as in Jinjira, Waiz ghat, Dholaikhal, Kamragichor, Dholai par where water from Buriganga river is available at nearby location.

Most of the shops in different recycling markets of Dhaka are established in last 8-10 years and they are handling mainly televisions, refrigerators and personal computers & related accessories such as UPS etc. The exponential growth and use of personal computers and their rapid obsolescence has led to the growth of these recycle shops. Thus it is found that television; computer and related accessories are the main source of in house e-waste in Dhaka city. Workers in most of the recycling shops are receiving monthly wage of approximately 3000-4000 BDT working for 10-12 hours daily. They are getting much less wage than the day laborers for this unhealthy and hazardous job. Most of the workers in the shops are using hammer, chisel and screwdriver as a tool to break down e-wastes. Sometimes they burn them to recover valuable material resulting in polluting the surrounding environment. If modern technology is used in recovering, then this work can be done more efficiently and in an environment friendly manner. The inefficiency in recycling is also resulting into higher quantity of scraps. Workers and owners of the shops don't think that recycling e-waste is hazardous at all. The lack of visibility of toxic material in e-waste by naked eyes is making them believe that these are non toxic. During the study it is observed that most of the people engaged in dismantling of e-waste are young aged mostly of 12 to 20 years as children and boys easily agree to work at a very low wage. The study also reveals that some part of the e-waste such as motherboard of pc and printed circuit board are illegally exported to China and India.

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As people involved in e-waste management are mostly illiterate they don't have much idea of health hazards of toxic substances present in e-waste. They rarely adopt any personal safety measures for example hand gloves, gas masks, safety goggles and boots during dismantling of e-waste. Nor even they are concern about the environment pollution. Figure 2 shows awareness level of the people directly involved in this sector, their health status as well as their concern regarding e-waste.

VII. ENVIRONMENTAL IMPACT DUE TO E-WASTE DISPOSAL

Environmental pollution due to e-waste in Bangladesh is lower than those of neighbour countries like China, India and Pakistan. Since Bangladesh is a low lying country so there could be a possibility of contamination of ground water and surface water bodies due to heavy metals and toxic substances of e-waste which is happening in most of the developed countries. But land filling which is one of the most adopted processes of recycling of e-waste is not practiced here. Plastic, glass, PVC and wire all of them are recycled to new products in industries

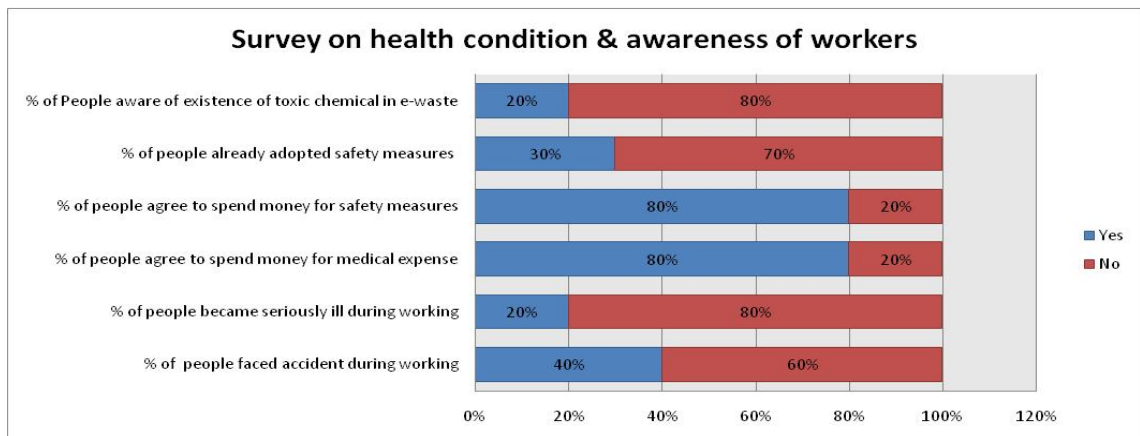


Figure 2: graphical presentation on health condition and awareness level of workers

Open burning of e-waste was previously exercised here in a very small scale which causes serious air pollution. Such case was found in Waizghat where battery waste were burned in open sky near the river Buriganga thus causing serious soil and water as well as air pollution. From the field survey very few areas have been found as in Figure 3.



Figure 3: Open burning of battery waste beside the river Buriganga in Waizghat

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If plastic waste recycling sector in Islambag is considered, very unhygienic environment of vangari shops were observed. Before melting, plastic waste is washed in nearby water body such as in Buriganga which is shown in Figure 4. This is polluting the river water. In plastic industries where raw materials are melted, huge amount of gas is emitted. So workers in that place and the inhabitants remain in great endangered environment. In Chankherpul huge amount e-waste is dismantled every day and soil is polluted thereby.



Figure 4: Washing and drying of plastic waste in Islambag beside the river.

Battery waste in Waizghat is washed in Buriganga river. So different metal like lead, cadmium, nickel, arsenic and acid like sulphate, nitrate are mixed with Buriganga river water in a significant quantity. Thus battery waste is polluting Buriganga river water (Figure 5) by increasing the heavy and toxic metal content as well as sulphate, nitrate.



Figure 5: Pollution of the river Buriganga due to battery waste.

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The Figure 6 expresses the experimental values of heavy metal content specifically lead, cadmium, iron, copper and chromium present in water samples collected from Buriganga river near Islambag & Waizghat and water from storm sewer in Chankherpul. Large amount of existence of iron, lead, cadmium, copper and chromium were observed in river water collected from the nearby e-waste hotspots.

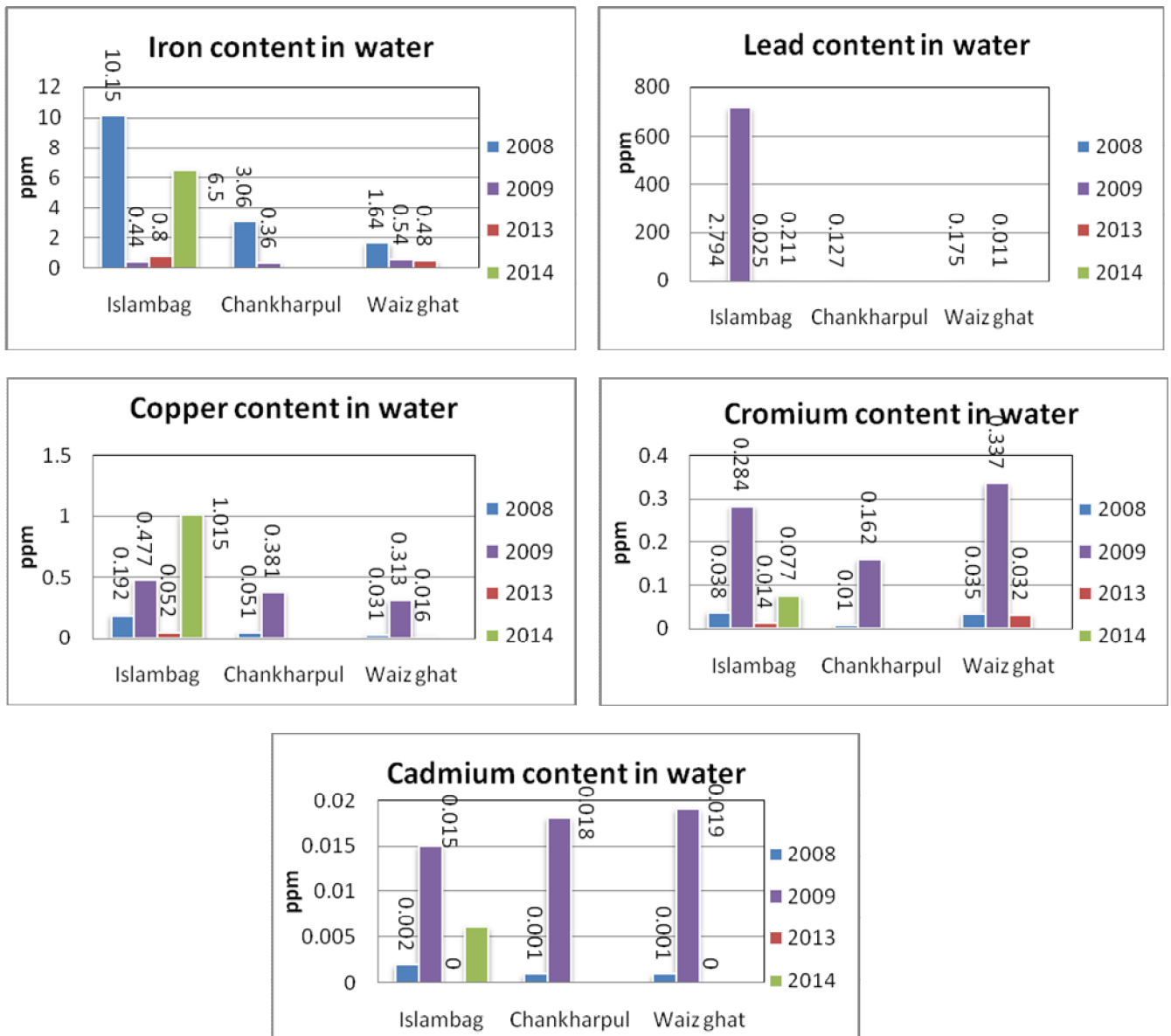


Figure 6 Graphical representation of water sample test results.

Heavy metal present in soil sample collected from Chankherpul, Islambag and Waizghat are also graphically shown in Figure 7. Heavy metal content of soil collected from those hotspots is also very high.

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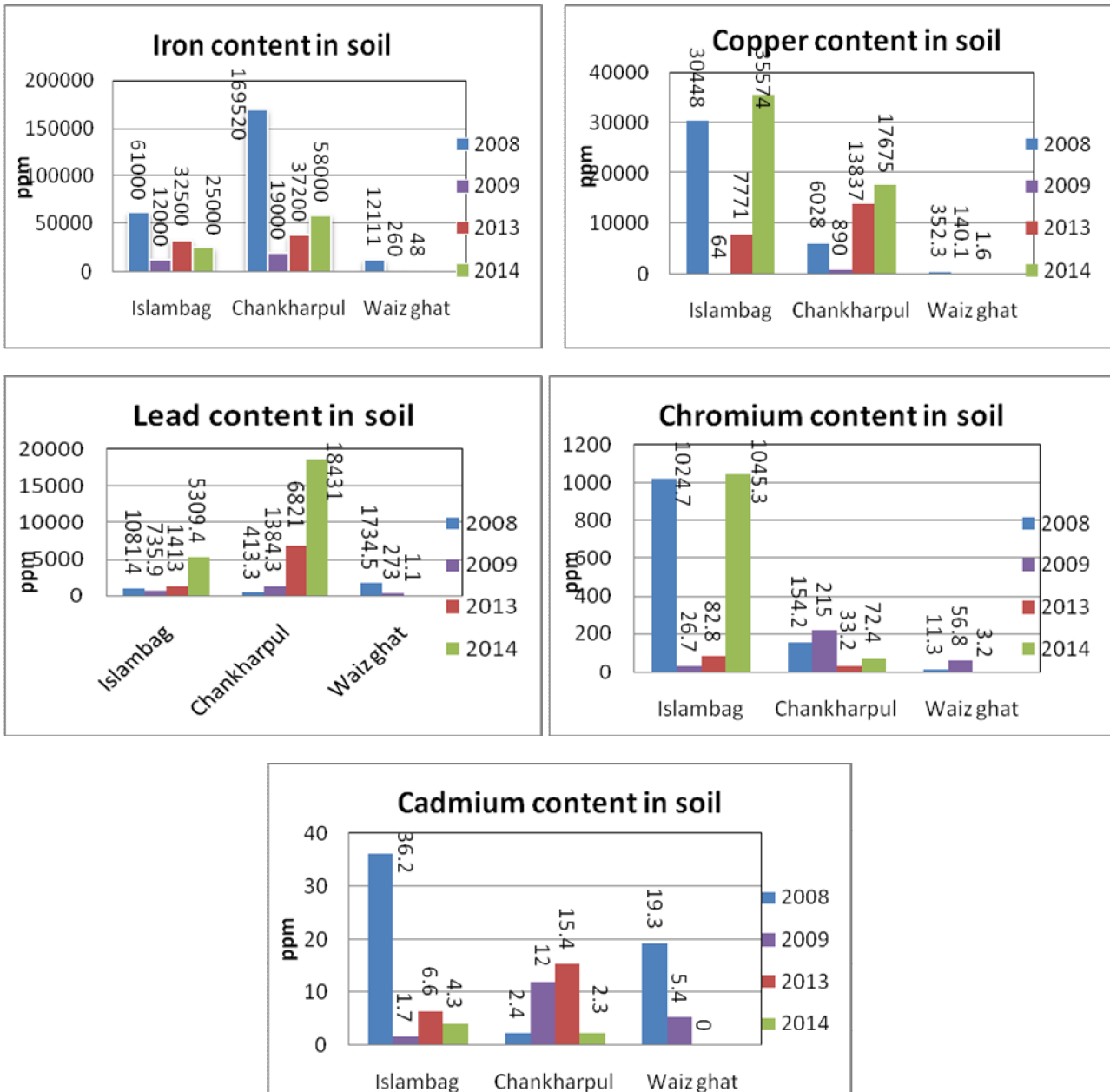


Figure 7 Graphical representation of soil sample test results.

From the bar chart of test results it is revealed that heavy metal content of both water and soil follows a decreasing trend from 2008 to 2014 for Waizghat. This is because open burning of battery waste on the river side near Waizghat has been already stopped from 2009.

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Table 2: Standard for several water quality parameters

Parameter	Inland Surface water	Drinking Water			
	Bangladesh standard (mg/l)	Bangladesh standard (mg/l)	WHO standard (mg/l)	EPA standard (mg/l)	USPHS standard (mg/l)
Fe	2	0.3-1.0	0.3	0.3	0.3
Cu	0.5	1	1.5	1.3	1
Pb	0.1	0.05	0.05	0.015	0.05
Cr	0.5	0.001	0.05	0.01	0.05
Cd	0.05	0.005	0.01	0.005	0.01

Table 2 represent the Bangladesh standard value for both drinking water and inland surface water for several water quality parameters for detecting water pollution. Some standards of other countries as well as guidelines are also mentioned here. By comparing the standard values with the test results it is observed that iron, lead and chromium in water has exceeded the limit. Copper is marginally within the limit and cadmium is still within the tolerable limit. Moreover it is required to mention that waste from nearby cottage industries is also disposed in this river. So it is difficult to say that the value of different parameters found in laboratory test is only due to the pollutant from e-waste. But e-waste does play a significant role in deteriorating the river water quality.

Several soil quality standards are also mentioned in table 3. By comparing test results of soil samples with standards it is observed that heavy metal content of soil is very high. Moreover in few cases an increasing trends in the heavy metal content of soil of e-waste hotspots is also observed. Being a low lying region there is a possibility of leaching of heavy metal into ground water during monsoon. At the same time there is a high risk of pollution of surface water bodies as monsoon water may wash out the surfaces of the e-waste hotspots and falls into the nearby rivers.

Table 3: USEPA standard for heavy metal content in soil.

Element	USEPA standard for common range of heavy metal (ppm or mg/kg)	Average concentration (ppm or mg/kg)
Iron(Fe)		
Lead(Pb)	2-200	10
Cadmium(Cd)	0.01-0.7	0.06
Copper(Cu)	2-100	30
Chromium(Cr)	1-1000	100

VIII. CONCLUSIONS

E-waste is one of the fast growing waste streams in the modern world because of rapid technological progress and decreasing lifespan of a single electronic device. The major objectives of this study was to collect information of e-waste, its source of generation, collection system, condition of people involved with handling and environmental pollution at different stages. Finally the following conclusions can be drawn:

Hawkers and scavengers are the main collectors of e-waste in the root level. Nimtoli, Chankherpul is the largest secondary e-waste accumulation centres in the city. Besides that there are very few areas in Elephant Road, Stadium

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market, Kodomtoli, Jinjira, Kamrangi chor, Segun Bagicha and Notun bazar where e-wastes are accumulated and dismantled. From the above study it is revealed that domestic electronic wastes generated mostly from home appliances are fully recycled. Land filling one of the major processes of disposal of e-waste is not exercised here. Open burning to recover valuable metal from e-waste is not exercised here in large scale. Handling, breaking and melting of e-waste pollute soil and air of waste accumulation shops (vangari shops), recycling industries and the surrounding environment. On the other hand cleaning process of e-waste affects the quality of water of nearer water body. According to the survey only 20% of the workers involved in e-waste dismantling sectors are aware of the toxicity of e-waste. About 80% people are agreed to spend few amount of their income to ensure safety (use of gas masks, goggles, boots, hand gloves etc) during working but the amount is very low. Survey also shows that 40% people faced accidents during working. 20% people became seriously ill during working and they need to hospitalize. Test results of heavy metal content of water samples collected from the water body near to the e-waste hotspots (Chankherpul, Islambag and Waizghat) shows the existence of large amount of Iron, Lead, Cadmium, Copper and Chromium. Though it is difficult to say that the value of those parameters found in laboratory test is only due to the presence of the pollutant from e-waste, but it is definite that e-waste does play a significant role in deteriorating the river water quality.

Test results of soil samples also indicate significant existence of heavy metal content of the soil of e-waste hotspots. Being a low lying region there is a possibility of leaching of heavy metal into ground water during monsoon. At the same time there is a high risk of pollution of surface water bodies as monsoon water may wash out the surfaces and falls into the rivers. Test results also reveal that heavy metal content of both water and soil follows a decreasing trend from 2008 to 2014 for Waizghat. This is because open burning of battery waste on the river side near Waizghat has already stopped. Bangladesh is not being used as dumping spot of e-waste by the developed countries yet and the groups of e-waste recyclers have not grown here. So she is still in safe position from the threat of external e-waste. Source of e-waste is the internal obsolete electronic products and its generation is higher in urban areas than that of rural areas in Bangladesh.

Proper attention needs to be paid to the informal e-waste dismantling sectors so that in future it does not become a threat to the country. In this regard proper quantification of e-waste, advance and sophisticated waste collection and disposal system, logistics and legal frame work and a technical solution need to be developed and implemented. Since study on e-waste management in Bangladesh is new so to get the actual view throughout the country future study on this topic is very necessary. There is a wide range of means and measures to influence WEEE (waste electrical and electronic equipment) generation, management and impacts, ranging from restricting its generation through better design, enhancing recycling and reuse schemes, introducing market forces into waste through product stewardship programmes, and more use of classic 'end of pipe' solutions such as technically engineered landfills. Well established principles such as 'polluter pays', 'prevention is better than cure' and the 'precautionary principle' have to be applied by the Government, in the effort to strike a balance between maintaining the benefits of WEEE while minimising the environmental and human health costs of WEEE.

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