

Study of Environmental Pollution by Electronic Waste In Chapra District of Bihar

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ABSTRACT

In this present paper, we studied about environmental pollution by e- waste in Chapra district of Bihar. The historical background of the district as available in Ain-E-Akbari records Saran as one of the six Sarkars (Revenue Divisions) constituting the province of Bihar, At the time of grant of Diwani to the East India company in 1765, there were eight Sarkars including Saran and Champaran. E-waste comprises waste electronics/electrical goods that are not fit for their original intended use or have reached their end of life. This may include items such as computers, monitors, printers, scanners, battery cells, cellular phones, DVD's, VCD's etc. (Singh et al., 2016; Rajya Sabha Secretariat Report, 2011). It generally contains thousands of toxic ingredients includes heavy metals such as lead, mercury, cadmium, arsenic, chromium and harmful chemical such as polychlorinated biphenyl (PCB), brominated flame retardant (BFR) and also contain a large part of valuable metal like platinum, gold, silver etc. (Rajarao et al., 2014). Due to the global recession and the decreasing demand for Rail products in the West forced the manufacturers and the handicraft workers to adopt the hazardous e-waste recycling to earn their livelihood.

Keywords : E-waste, Environmental Pollution, Soil Texture, Vehicular Pollution

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I. INTRODUCTION

The handicraft workers are experts in crafting metals but now are experienced at extracting metals from electronic products. The workers utilizing unconventional, uncontrolled, primitive and crude procedures such as acid bath, open air burning to recycle and recover valuable metals like gold, silver from e-waste. These processes leads to the release of

toxic or hazardous substances such as heavy metals (like mercury, lead, cadmium), brominated flame retardants (BFRs), neurotoxins and volatile compound of nitrogen and chlorine etc. into the environment which consequently resulting in the pollution of the land, ambient air and water (Kiddee et al., 2013). These recycling activities also poses a high risk to health problems that could affect people when exposed to such hazardous substances include acute

lung damage, stemming from the inhalation of fumes of heavy metals such as lead and cadmium etc. (Sepulveda et al., 2010).

The growth of the city over the last thirty years has been rapid and diverse, and continues to date. Unfortunately, due to lack of awareness and proper regulations, these developmental activities were accompanied by environmental degradation i.e. deterioration of soil and air quality (Pal et al., 2014a) which in turn poses high risk to vegetation and human health.

II. Materials and methods

Vehicular Pollution:

It has been estimated that vehicular pollution is the primary cause of air pollution in the urban areas (60%) followed by industrial areas (20-30%) in India (Prajapati et al., 2009; Barman et al., 2010). Vehicles emit various pollutants including fine and coarse particles in close proximity to the breathing zone of the people and therefore make it necessary to consider localized as well as general effects on the atmosphere (Gangwar et al., 2016). The major changes in the environmental composition are principally ascribable to the fuel combustion, which is either used for the generation of energy or transportation. Although chemicals generated during vehicular combustion principally differ, it is believed that a vehicle engine during the combustion of 1 kg gasoline utilizes 15 kg of environmental air, and produces 4~20g nitrogen oxides (NO_x), 4~9g hydrocarbon (HC), 150~200g carbon monoxide (CO) and several elemental pollutants. The vehicular pollution in Chhapra city has increased many folds due to the increasing no. of vehicles in the city. The vehicles population had arisen to 40551 in 2020-2021 with number of vehicles being added every day (Figure 1).

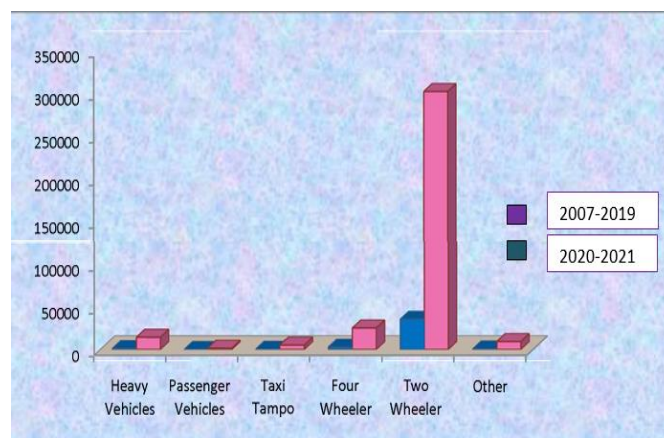


Figure 1 : Vehicles recorded in Chhapra City during the year 2007-2019 and 2020- 21 (Source: RTO, Chhapra)

2.2 Physicochemical Parameters of Soil:

Soil texture:

Hydrometer method (Bouyoucos, 1951) was used to determine the soil texture. It measured the percentage of sand, silt and clay in the inorganic fraction of soil and based on Stoke's law governing the rate of sedimentation of particles suspended in water. Soil samples were treated with sodium hexametaphosphate (HMP) to complex Ca⁺⁺, Al⁺, Fe⁺, and other cations that bind clay and silt particles into aggregates. The density of the soil suspension was determined with a hydrometer calibrated to read in grams of solids per liter, after the sand settled out and again after the silt settled. Corrections were made for the density and temperature of the dispersing solution. Firstly, blank solution was made by mixing 100 ml of the 5% dispersing solution and 880 ml of deionized water in a 1000 ml cylinder. Then, 25 to 50 gm of soil was transfer to a dispersing cup and weight was recorded to ± 0.01 gm. After this, 100ml of 5% dispersing solution was added to it and dispersing cup was attached to mixer. This sample was mixed for 30-60 sec. After mixing, suspension was transferred quantitatively from the dispersing cup to a 1000 ml cylinder and made it to 1000 ml by adding deionized water and equilibrated it to room temperature for overnight. At the beginning of each set, temperature and hydrometer reading of the blank was recorded.

Density of soil suspension was determined by inserting the plunger into suspension, and carefully mixed for 30 sec. until a uniform suspension was obtained. After this, plunger was removed and gently inserted the hydrometer into the suspension. The hydrometer reading was recorded at every 40 sec. This was the amount of silt as well as clay suspended. The sand was settled to the bottom of the cylinder by this time. For each sample, this procedure was repeated again. After 6 hours and 52 minutes, the hydrometer reading was recorded again to measure the amount of clay in suspension. The silt was settled to the bottom of the cylinder by this time.

Calculation

For Percent clay, % clay = corrected hydrometer reading at 6 hrs. 52 min. x 100/ wt.

For Percent silt,

% silt = corrected hydrometer reading at 40 sec. x 100/ wt - % clay

For Percent sand,

% sand = 100% - % silt - % clay

Where,

wt. = Weight of sample

Soil pH:

Soil pH was determined by electrometric method. Measurement of pH involved the detection of charges in glass electrode using a pH meter standardised against known buffer solutions of 4 and 6.86. Soil-deionised water (1:5) suspension was prepared by adding 10gm air-dried soil in 50 ml of deionised water. The electrode was washed thoroughly with deionised water between measurements. After that, electrode was immersed into the soil suspension and pH was recorded. The pH value obtained when the equilibrium was reached while stirring with a mechanical stirrer.

Soil Temperature:

Temperature of a soil samples was determined immediately after it was collected with the help of simple soil thermometer.

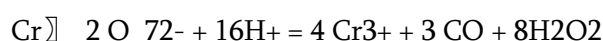
Electrical Conductivity (EC):

Electrical Conductivity is used to determine the soluble salts concentrations present in the soil suspension. To determine the EC in soil samples, 20 gm of air-dried soil were added into a 40 ml of distilled water and this solution was shaken on a rotary shaker for 10 to 15 minutes. After this, solution was filtered through whatman filter paper number 1 and a clear solution was obtained. The EC of this clear solution was then determined using a microprocessor based digital conductivity meter.

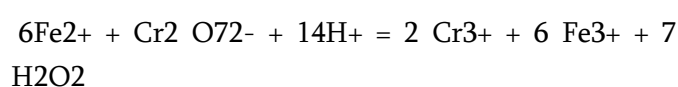
Soil Organic Carbon (SOC) and Soil Organic Matter (SOM):

Walkley-Black chromic acid wet oxidation method was used to determine SOC which utilized a specified volume of acidic dichromate solution reacting with a determined amount of soil in order to oxidize organic matter (Walkley and Black, 1934). In this reaction carbon was oxidized by the dichromate ion. Excess dichromate ion was then back titrated with ferrous ion.

Dichromate ion reacts with carbon as follows:



Ferrous ion reacts with dichromate as follows:



1gm soil was taken into a 500 ml erlenmeyer flask and 10 ml. of 1N potassium dichromate solution was added to it. Now 20 ml sulfuric acid was also added and mix by gentle rotation for 1 minute. After 30 minute, this solution was diluted to 200 ml with deionized water. Now 10 ml phosphoric acid, 0.2 gm ammonium fluoride and 10 drops diphenylamine indicator was titrated with 0.5N ferrous ammonium sulfate solution until the color changes from dull green to a turbid blue. The titrating solution was

added drop by drop until the end point was reached when the color shifts to a brilliant green. Blank determinations were similarly made and the percentage organic carbon was calculated using the following formula.

$$\text{Organic Carbon (\%)} = \times 100 \frac{(B-T) \times 0.5 \times 0.003 \times 1.33}{\text{Wt.}}$$

Where,

B = Blank titre value, T= Sample titre value, F = Correction factor = 1.33, and 0.5N is the concentration of ferrous ammonium sulphate.

Estimates of total organic carbon (OC expressed as C) were used to assess the amount of organic matter in soils. Organic matter was calculated as follows:

$$\% \text{ Organic Matter} = \% \text{ Organic Carbon} \times 1.724$$

Available Nitrogen (AN)

Nitrogen (N) is one of the major nutrients required for the growth of plants. Available nitrogen was determined by Kjeldahl Method (Kirk, 1950). 500 mg oven dry soil samples were taken into digestion tube. Then, 5 ml concentrated H₂SO₄ and 1 gm catalyst was added into digestion tube. After that, digestion tube was placed in digestion unit and heated to boiling until green color appears. After complete digestion, the digestion tubes were allowed to cool for 5-10 minutes outside the digestion unit and then 20 ml of distilled water was used to dilute the contents. Finally, the volume was made up 50 ml.

Distillation was done in the micro Kjeldahl apparatus. 10 mL digest (aliquot) was placed in steam chamber of Kjeldahl apparatus after adding 10 ml of 2N NaOH. A 50 ml conical flask containing 10 ml of H₃BO₃, a few drops of mixed indicator, which was placed under the condenser, steam of the distillation apparatus. The liberated NH₃ + -N, liberated by distillation of the digest with 2N NaOH was absorbed in stabilization H₃BO₃ in the form of ammonium borate. The contents were titrated against standard 0.01N HCl by auto- titrator. A blank solution was also prepared by above method without soil sample.

Calculation: -

$$\text{AN (\%)} = \frac{(T-B) \times \text{Molarity of Standard HCl} \times 1.401}{\text{Wt.}}$$

Where,

T = Volume of standard HCl for titration of the soil sample;

B = Volume of standard HCl for titration of the blank solution;

Wt.= Weight of sample

Available Phosphorus (AP):

It was determined by Olsen Colorimetric method (Olsen et al., 1954). This method estimates the relative bioavailability of ortho-phosphate (PO₃⁻) in soils by extraction using alkaline sodium bicarbonate (pH 8.5) solution and determining the P concentration in the extract calorimetrically. 2.5 gm of soil was taken into a beaker and 50 ml of 0.5M sodium bicarbonate (pH 8.5) solution was added to it and this mixture was shaken for 30 minutes. After that, mixture was filtered through whatman filter paper and ortho-phosphate in the filtered extract was determined calorimetrically at 630nm by reacting it with ammonium molybdate using ascorbic acid as the reducing agent. Results were reported as parts per million (ppm) phosphorus (P) which is converted into kg/ha in the soil.

Calculation: -

Available phosphorous (mg/ kg) was calculated as follows:

$$\text{Soil AP (mg/kg)} = [(A \times B \times C \times M)/E]$$

Where,

A = Sample extract reading (mg/l);

B = Extract volume (ml);

C = Dilution, if performed;

M= Moisture correction factor;

E = Sample weight (g).

2.5 Heavy Metal Analysis of Soil:

Soil samples were collected from a depth of 10-20 cm at various study sites and stored in air tight plastic temperature, grinded and sieved through a 200-um

mesh nylon sieve to remove debris containers. After that soil samples were air dried at room (These soil samples were collected in every month during the year 2015 and 2016).

The sieved samples were dried for 24 hrs. After that, 0.5 gm of air-dried soil was taken into the beaker and digested with 15ml of concentrated HNO₃, H₂SO₄, and HCL (5:1:1) solution at 80oC until the transparent solution was obtained. The digested solution was coolent and then filtered by Whatman's filter paper number 42. Filtrate of digested soil was diluted with deionised water before heavy metal determinations (Pb, Cd, Cu, Cr, Zn and Ni). It was kept at room temperature for further analysis of heavy metals. Heavy metal concentrations of each fraction were determined with Atomic Absorption Spectrophotometer (AAS, GBC, Avanta (version 2.02), Australia) assurance that was guaranteed through double determinations and use of blanks for correction of background and other sources of error. Concentration of heavy metal was calculated by following formula:

$$C \text{ (mg/kg)} = \frac{(\text{Simple Conc.} - \text{Blank Conc.}) \times \text{Final Volume}}{\text{Weight of the Simple (gm)}}$$

III. RESULTS AND DISCUSSION

For soil quality assessment, various physicochemical properties of soil such as texture, pH, temperature, electrical conductivity, organic matter, organic carbon, available nitrogen and phosphorous were analysed in soil samples of various study sites. Besides this, heavy metals like Pb, Cd, Cu, Zn, Cr and Ni were also investigated in soil samples of different study sites. Major findings related to soil physicochemical analysis which was found in this study are as follows: It was found that sand dominates over silt and clay in all the studied sites and 80% study sites had sandy loam textural class. Soil of e-waste burning cum industrial areashad lower pH value which could not

be linked only with basic metabolites accumulation but also high mineral content of the soil.

- ❖ Highest soil temperature was recorded at e-waste burning cum industrial sites in comparison to control area which indicated that soil temperature fluctuates daily and seasonally which may consequences from changes in solar energy and changes in energy taking place through surface of soil. High EC values at e-waste burning cum industrial areas than other study sites revealed that e-waste burning and industrial activities causes high concentration of ionic substance and soluble salts in soil of various study sites.

- ❖ Organic carbon and organic matter were also found higher at e-waste burning cum industrial areas that may be attributed to e-waste burning activities which probably as many organic components. High organic carbon and matter content entails larger adsorption surfaces and more metals are adsorbed to organic material.

- ❖ High level of available nitrogen in soil sample of e-waste burning cum industrial areas may be ascribed to dumping of waste along with residual waste left after burning of e-waste. Although nitrogen can be introduced into the soils by natural processes such as lightening, decay of plant tissues etc. Low levels of available phosphorus were observed in soil of e-waste burning cum industrial areas may be due to the loss of some content of phosphorous into the environment by volatilization during e-waste burning. Presence of high content of phosphorous leads to loss of nitrogen content of soil of various study sites.

- ❖ Heavy metal analysis of soil revealed that the soil of e-waste burning cum industrial sites had significant amount of studied heavy metal. High concentration of heavy metals (such as Pb, Cu, Cd and Ni) in these areas may be due to informal e-waste recycling that includes open air burning, dismantling, incineration and acid bath etc. Besides this industrial (Cu, Zn, Cr, Ni) and vehicular activities (Pb, Cd) are also a major source of heavy metal concentration in soil which were found several times higher when compared with the CCME, Canadian and USEPA soil standards at all

study sites except control site. Heavy metal concentrations of soil were obtained lower in monsoon season as compared to winter and summer which is assigned to the high precipitation in monsoon season which leads to the dilution of soil and leaching of cations down the profile.

IV. Conclusions

It was concluded from the findings of soil physicochemical analysis that e-waste burning along with the industrial activities may leads to the high values of soil temperature, electrical conductivity, organic carbon, organic matter, available nitrogen as well as heavy metals concentrations at e-waste burning cum industrial areas. Besides this, these activities are also responsible for low levels of pH as well as available phosphorous in e-waste burning cum industrial areas.

V. REFERENCES

- [1]. Text of the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, UNEP, Geneva, Switzerland, p.6, <http://www.basel.int/text/>
- [2]. Performance Audit on "Management of Wastes in India", Report No. PA 14 of 2008, www.cag.gov.in/html/reports/civil/2008_PA14_SD.../chap_1.pdf
- [3]. Amit Jain, 'Global e-waste growth' in Rakesh Johri, E-waste: Implications, regulations and management in India and current global best practices, TERI, New Delhi, 2008, p.4
- [4]. "Rules on e-waste management by March", The Hindu, 20 December 2009.
- [5]. Neha Lalchandani, 'E-scare', The Times of India, 24 April 2010.
- [6]. Ibid n.3, p.3
- [7]. The Basel Action Network (BAN) and Silicon Valley Toxics Coalition (SVTC), Exporting Harm: The High-Tech Thrashing of Asia, February 25, 2002.
- [8]. The IAER was acquired by the Institute of Scrap Recycling Industries, Inc. (ISRI) in January 2009. ISRI, based in Washington D.C., USA, is the voice of the scrap recycling industry, an association of companies that process, broker and consume scrap commodities.
- [9]. UNEP Press Release, 'Basel Conference addresses Electronic Wastes Challenge', 27 November 2006
- [10]. Ravi Agarwal, 'A Policy? Rubbish', The Hindustan Times, 4 May 2010
- [11]. Lok Sabha Unstarred Question no.650, dt. 28.07.2010.
- [12]. Sandeep Joshi, 'Growing e-waste is causing concern', The Hindu, 28 February 2009.
- [13]. Moushumi Basu, 'New e-waste management plan lucrative for states', The Pioneer, New Delhi, 18 May 2010.
- [14]. 'Disposal of e-waste', Rajya Sabha Unstarred Question no. 1887, dt. 07.12. 2009. Also see, Sanjay Jog, 'Ten states contribute 70% of e-waste generated in India', The Financial Express, 13 March 2008.
- [15]. Satish Sinha, 'Downside of the Digital Revolution', Toxics Link, 28 December 2007.
- [16]. 'Mayapuri: Disaster protocol not clear, says health minister', The Times of India, New Delhi, 04 May 2010.
- [17]. Comments and Suggestions made by the Ministry of Environment and Forests, Government of India on the draft backgrounder titled 'E-waste in India' prepared by the Research Unit of Rajya Sabha Secretariat. O.M. No. 23-4/2011-HSMD, dated 19 April, 2011.

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