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THE IMPACT OF MUNICIPAL SOLID WASTE DUMPING ON SELECTED SOIL CHEMICAL PROPERTY IN THE CASE OF SEBATAMIT, BAHIR DAR, ETHIOPIA

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GRADUATE PROGRAM

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M.Sc. Thesis

By

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August 2020

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SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE (MSc.) In ENVIRONMENT AND CLIMATE CHANGE

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Bahir Dar, Ethiopia

THESIS APROVAL SHEET

As member of the Board of Examiners of the Master of Sciences (M.Sc.) thesis open defense examination, we have read and evaluated this thesis prepared by Mr. Yonas Ayitenew Getnet entitled "**The Impact of Municipal Solid Waste Dumping on Selected Soil Chemical Property in the Case of *Sebatamit*, Bahir Dar, Ethiopia**" and examined the candidate. We hereby certify that the thesis is accepted for fulfilling the requirement for the award of the degree of Master of Sciences (M.Sc.) in Environment and Climate Change.

Board of Examiners

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Name of External Examiner	Signature	Date
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DECLARATION

This is to certify that this thesis entitled **The Impact of Municipal Solid Waste Dumping on selected soil chemical property in the case of *Sebatamit,* Bahir Dar, Ethiopia.** This thesis has been submitted in partial fulfillment of the requirements for the award of the degree of Master of Science in Environment and climate Change to the Graduate Program of College of Agriculture and Environmental Sciences, Bahir Dar University by Yonas Ayitenew Getnet (ID. No. BDU 1108084R) is an authentic work carried out by he under our guidance. The matter embodied in this project work has not been submitted earlier for the award of any degree or diploma to the best of our knowledge and belief.

Name of the Student

Yonas Ayitenew Getnet Signature _____________date _____________

Name of the Advisers

1. Solomon Addisu (PhD) Signature_____________date______________
   Main Advisor

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DEDICATION

I dedicated this thesis manuscript to my beloved family.

LIST OF ACRONYMS/ABBREVIATION

ANRS	Amhara National Regional State
CM	Cent meter
CSA	Central Statistical Agency
Cu	Copper
DTPA	Diethylene Triamine Pentacetic Acid
Fe	Iron
HHs	Households
IMSWM	Integrated Municipal Solid Wastes Management
MM	Milli meter
MSE	Micro and Small Enterprises
MSW	Municipal Solid Wastes
MSWM	Municipal Solid Wastes Management
Av. P	Available Phosphorus
SBPDD	Sanitation Beatification and Parks Development Department
SD	Standard deviation
SOC	Soil Organic carbon
SWM	Solid Waste Management
TN	Total Nitrogen
UNEP	United Nation Environmental Panel
WMH	Waste Management Hierarchy
Zn	Zinc

ABSTRACT

*All types of waste and open disposal of waste can cause environmental degradation by introducing different toxicants including heavy metals. There is lack of comprehensive and detailed studies about the concentration of chemical properties of soil around solid waste disposal sites. This study was conducted in Bahir Dar city administration sebatamit waste dumping site. The objective of the study was to investigate the impact of municipal solid waste dumping on selected soil chemical property and to assess the perception of communities on solid waste dumping. A total of 24 (4*2*3 replications) soil sample was collected by using circular methods from the depth of 0cm-25cm and 25-35cm including control site to analyze pH, Soil Organic Carbon, Total Nitrogen, Available Phosphorus, Iron, Zinc, and Copper. A total of 397 respondents were administered for the socioeconomic data sources. The data obtained from laboratory and field measurements were analyzed by using statistical package for social science (SPSS) version 20 software. The findings of the study revealed that the concentration of chemical property of soil was higher in dumpsite than the control site. The main types of municipal sold waste in Bahir Dar town are paper, glass, plastic, ash, fruit residual and bone and the physical composition of MSW in the town is composed of both biodegradable and non-degradable components, the current implementation rule and regulation related to municipal solid waste management practice of town are weak and also the improper municipal solid waste management poses a potential risk to Environment, Animal health, and human health. The present dumpsite is treated accordingly to minimize the impact of persistent heavy metals in the area or City administration should find a proper landfill site by taking all environmental, social, economic, and political considerations.*

Key Word: Bahir Dar, Chemical Property of Soil, Solid Waste, Solid Waste Management

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Chapter 1. INTRODUCTION

1.1. Background and Justification

The municipal solid wastes (MSWs) are unwanted materials mainly consisting of household wastes and so are called household garbage. They include waste from crafts, trades, hotels, schools, public services, and hospitals and municipal services such as road wastes, parks and gardens' maintenance, and other recreational areas (Ramachandra *et al*., 2018). Municipal solid wastes covers solid wastes generated by households, commercial waste from shops, hotels, garages & agriculture and institutions like schools, hospital care homes, prisons, and public spaces such as streets, bus stops, parks, and gardens (Lohri *et al*., 2013).

Solid Waste is any waste that is neither liquid nor gas and is discarded as unwanted. Solid Waste Management (SWM) means the collection, transportation, recycling, or disposal of solid waste, or the subsequent use of a disposal site that is no longer operational (Damtew and Desta, 2015). The quantity of waste has increased over the years in the developing countries, and their management faces many difficulties from the technical and economical sides as from the methodological and organizational sides. Facing this reality, open landfills (dumps) have become the only available way for their elimination (Pastor and Hernández, 2012).

The landfill or dump is still worldwide and very common for solid waste disposal method. It is the simplest practice and the most economical of this type of wastes storage in a lot of countries, particularly in developing countries (Breza-Boruta *et al*., 2016).

As development continues, SWM becomes a major public health and environmental threat in urban areas. The daily life in industrialized nations can generate money of waste per consumer, not only directly in the home, but also indirectly in factories (Sarker *et al*., 2012). Therefore, even though SWM is now here adequately executed and is a global problem, especially in underdeveloped countries, the problem of disposal of waste is the environmental impact and unsolved which further leads to several illnesses caused by infectious and parasitic diseases (Fenta, 2017).

The annum speedy urbanization in Ethiopia, leading to overcrowding and the development of slums and informal settlements with poor waste management practices. Urban dwellers generally consume more resources than rural dwellers, and so generate large quantities of solid waste and sewage (Gedefaw, 2015).

Various types of wastes like an old computer, tin cans, and E-waste and old battery are few examples that contribute heavy metals in landfills. Released leachate in the surrounding environment presents a risk to human health (Remigios, 2010). All types of waste and open disposal of waste can cause environmental degradation by introducing different toxicants including heavy metals. Pollution of soil by heavy metals is a global concern and presents a serious problem (Muniafu and Otiato, 2010).

Continuous addition of solid waste has adverse effects on the environment particularly leaching from the dumpsite when it contains potentially toxic heavy metals. These metals are known to bio-accumulate in soil and have long persistence time through interaction with soil components and consequently enter the food chain through plants and animals (Okeyode and Rufai, 2011).

According to UNEP (2010), Ethiopian cities such as Bahir Dar faces the problem of sanitation in general and SWM in particular. The daily waste generation rate in Bahir Dar city is also increasing from time to time (Fenta, 2017). But the current waste collection capacity and disposal system is not matching with the rapid expansion of the city and its corresponding waste generation. It encounters problems like shortage of sacks, roadside waste bins, public toilets, and the absence of proper and well-prepared disposal sites.

1.2. Statements of the Problem

Unsuitable disposal of MSW causes all types of pollution: air, soil, and water. Unselective dumping of wastes contaminates surface and groundwater supplies. Open dumping is quite common in developing countries due to the low-budget available for waste disposal (Amoah and Kosoe, 2014).

There is a lack of comprehensive and detailed studies about the content of heavy metals and properties of soil around solid waste disposal facilities in developing countries including Ethiopia. There are suggestions for further studies on heavy metals content in the soil profiles closer to dumpsites (Dabonne *et al*., 2010).

The growing concerns of health and environmental risks in the landfill area are now becoming more serious as different incompatible land uses are surrounding the site. In countries like Ethiopia, where there is a general lack of awareness of the risk associated with long-serving open solid waste dumpsites (Beyene and Banerjee, 2011).

Dumping type of disposal method which widely practiced in many developing countries and has a hazardous effect on health and the environment (soil). As a result, municipal solid waste management in Bahir Dar city has not been carried out in a sufficient and proper way. The environmental health conditions of the town have become more serious from time to time, and people are suffering from living in such conditions (Kassie, 2016). Solid waste management has been a serious challenge to all over the world. Bahir Dar city is characterized by rapid population growth caused by natural increase and migration from the rural area.

1.3. Research Questions

This research intended to answer the following research question.

I. What are the impacts of municipals solid waste on soil chemical properties within the dumpsite and surrounding environment in the area?

II. What are the municipals solid waste management system of Bahir Dar?

III. What do you understand the dumping and its associated health and environment impact in the study area?

1.4. Objectives of the Study

1.4.1. General objective

The general objective of the study was to investigate the impact of municipal solid waste dumping on selected soil chemical properties and the perception of communities on solid waste management in the study area.

1.4.2. Specific objectives

The specific objectives of this research were to: -

I. Examine the impacts of municipal solid waste disposed on soil chemical properties within the dumpsite and surrounding environment.

II. Investigate the municipals solid waste management system of Bahir Dar.

III. Assess the perception of communities on dumping and its associated health and environment impact.

1.5. Significance of the Study

This study is expected to be contributed to the understanding of the impacts of dumping site on soil chemical property in the study area. It contributed to the theoretical understanding of the overall features of municipal solid waste and problems faced in the process of municipal solid waste management. It gives some guideline information to policy makers, public administrators, solid waste managers, municipal leaders, researchers and environmental protection agencies who seek to improve existing solid waste management and to minimize related problems in the study area.

It also significant in putting baseline information to the next work as a springboard for researchers who would like to conduct detailed and comprehensive studies either in the city or another study area.

1.6. Organization of the thesis

The thesis is organized into five chapters. The first chapter has described the introduction, background and justification, statements of the problem, research questions, objectives of the study, significance of the study and organization of the thesis. The second chapter has described literature review. Chapter three discusses the materials and methods, description of the study area, sampling techniques and frame, samples of household, soil sampling method, data sources, methods of data collection, laboratory analysis and methods of data analysis. Chapter four constitutes the results and discussion of the study. The fifth chapter summarizes the finding of the study and the recommended possible solution.

Chapter 2. LITERATURE REVIEW

2.1. Concept of Municipals Solid Waste

Solid waste is material which no longer has any value to its original owner, and which is discarded. Solid waste in urban areas may including kitchen waste and garden trimmings, paper, glass, metals, plastics, Ash, dust, and street sweepings can also form a significant portion of the waste (Rouse, 2008).

Solid waste is any type of wastes that is hard neither a water-like nor liquid form; for example, used plastic bags, broken bags, leftover food or foods remains, and the like (Wendimagegn, 2019). It is a by-product of human activities that tends to increase with the rate of urbanization, changing patterns of consumption, and the improvement of living standards (Aschalew *et al.*, 2018).

2.2. Classification of solid waste

Solid waste grouped into its origin, risk potential, or characteristics. Based on origin, solid waste can be classified into food waste, rubbish, ashes and residues, agricultural waste, municipal service, industrial process waste, and demolition and construction wastes. With regards to characteristics, it also classifies as biodegradable and non – biodegradable. Based on its risk potential, categorized into hazardous and non-hazardous wastes. Wastes are broadly classified into municipal solid waste (MSW), industrial waste, and biodegradable waste (Ray, 2008).

Waste is classified differently in different contexts. The following classification is adapted from (Suryawanshi *et al.*, 2013) as:

Biodegradable waste*:* it originates from plant and animal sources, which may be broken down by microbes or other living organisms. While these wastes may appear physically different, they tend to be fairly homogeneous in biochemical composition (carbohydrates, fats, and proteins) for anaerobic digestion for biogas production by virtue of their high methane potential.

Hazardous waste: It is potentially dangerous or harmful to human health or the environment, includes by-products of manufacturing processes, discarded used materials, or discarded unused commercial products (cleaning fluids, pesticides). Hazardous waste of Bahir Dar City includes:

wastes from hospitals and medical laboratories, chemically contaminated containers and trimmings from agriculture, pesticide retailer shops, university, and school laboratories, tanneries, textiles, printing enterprises and expired drugs, biological wastes from hospitals and biological research facilities, the dry cells from each source and car batteries from garages, used condoms from hotels and pensions and fluorescent lamps to (UNEP, 2010).

Recyclable waste: Is the removal of items from the waste stream to be used as raw materials in the manufacture of new products (paper, glass bottles, and ceramics).

Inert waste: Are consists of construction and demolition waste, dirt, rocks, debris, etc. wastes relatively lower environmental impact by virtue of its non-biodegradability.

However, solid wastes are usually classified based on their sources (from which they emanate). Based on this benchmark, it can be categorized into domestic or household, commercial, institutional, industrial, municipal services, construction and demolition, agricultural wastes (Hoornweg and Bhada-Tata, 2012). The explanation of each type of waste summarized as follows (Table 2.1).

Table 2. 1.Sources and types of solid wastes

Source	Typical waste generators	Types of solid wastes
Household	Single and multifamily Dwellings	Food wastes, paper, cardboard, plastics, textiles, leather, yard wastes, wood, glass, metals, ashes, special wastes (e.g. bulky items, consumer electronics, white goods, batteries, oil, tires), and household hazardous wastes
Industrial	Light and heavy manufacturing, fabrication, construction sites, power and chemical plants	Housekeeping wastes, packaging, food wastes, construction and demolition materials, hazardous wastes, ashes, special wastes
Commercial	Stores, hotels, restaurants, markets, office buildings, etc.	Paper, cardboard, plastics, wood, food wastes, glass, metals, special wastes, hazardous wastes
Institutional	Schools, hospitals, prisons, government centers	Same as commercial
Construction and demolition	New construction sites, road repair, renovation sites, demolition of buildings	Wood, steel, concrete, dirt, etc.
Municipal Services	Street cleaning, landscaping, parks, beaches, other recreational areas, water and wastewater treatment plants	Street sweepings, landscape and tree trimmings, general wastes from parks, beaches, and other recreational area, sludge

Source: (Hoornweg and Bhada-Tata, 2012)

2.3. Municipals Solid Waste Management

According to (Clark *et al.*, 2013), SWM is defined as that the discipline associated with the control of generation, storage, collection, transfer and transport, processing and recovery, and final disposal of both organic and inorganic solid wastes in a manner that is in accordance with the best principles of public health, economics, engineering, urban and regional planning, conservation, aesthetics, environmental considerations.

Solid waste management includes all administrative, financial, rule and regulation and engineering functions involved in the whole spectrum of solutions to problems of solid wastes thrust upon the community by its inhabitants. To alleviate such problem should involve different fields, such as political science, city and regional planning, economics, public health, sociology, demography, communications, engineering, and materials science (Heidemann *et al*., 2006).

Integrated Solid Waste Management (ISWM) is wide-ranging waste prevention, recycling, composting, and disposal program. The best ISWM system considers how to avoid, reduce, recycle, reuse, and manage solid waste in ways that most effectively protect human health and the environment. SWM involves assessing local needs and conditions, and then selecting and combining the most suitable waste management activities for those conditions. It is also recognized at the international level, and they incorporate all the policies, programs, and technologies that are necessary to manage the waste stream. The mix and emphasis of approaches that are taken generally varies from region-to-region and from country to- country, and depends on local conditions (Gertsakis and Lewis, 2003).

The “Waste Management Hierarchy” (WMH) is a globally recognized strategy for management of municipal solid wastes and it is a key element of integrated solid waste management. It also places the greatest emphasis on strategies and programs for avoiding and reducing waste, with treatment and disposal being the least favored options.

The aim of the WMH is to make waste management practices as environmentally sound as possible. It has been adopted in various forms by most industrialized countries. Its primary elements are also included in international conventions and protocols, particularly those dealing with the management of toxic or hazardous wastes, and in regional attempts to develop a harmonized policy on the reuse of various byproducts of waste management processes. The WMH is useful for protecting resources, for dealing with landfill shortages, for minimizing air and water pollution (Puthillath and Sasikumar, 2015).

According to (Gertsakis and Lewis, 2003) the solid waste management hierarchy includes source reduction, Reuse. Recycle, Resource recovery, and Landfills.

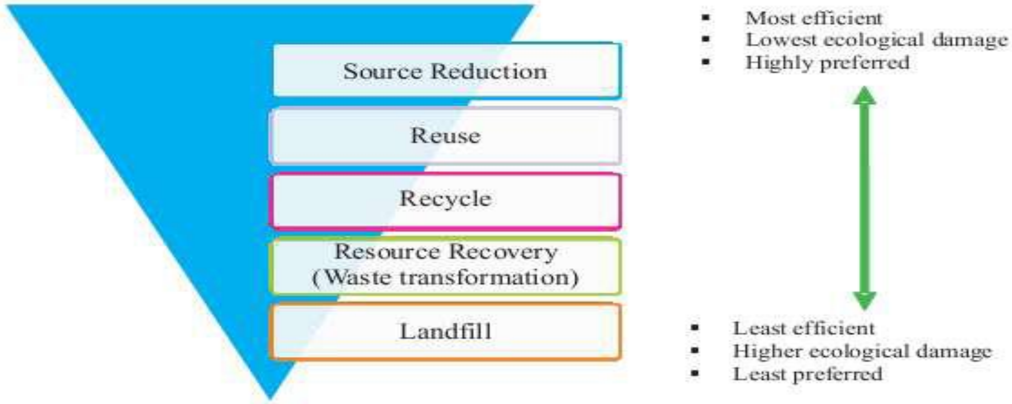

Figure 2. 1. Waste Management Hierarchy

Sources: (Gertsakis and Lewise,2003)

MSWM is successful through a critical phase, due to the lack of appropriate facilities for the collection, transportation, treatment and disposal of the larger quantity of MSW generated daily in urban areas (Thanh *et al*., 2010). This is mainly because SWs that are generated in most towns of Ethiopia are not appropriately handled and managed (Cheru, 2011a).

SWM is a managing system of solid wastes which include all the activities ranging from generation to disposal. According to (Rouse, 2008), SWM system should be simple, affordable, sustainable economic efficient, environmentally sound and socially acceptable and providing the service for both the poor & wealthy households and the collection, storage, transportation, processing, treatment, recycling, and final disposal of waste.

There are no appropriate solid waste management systems employed in most developing countries. Lack of appropriate management plan, institutional framework and financial resources are the problem of the current management system. Beyond these, rapid rate of urbanization and increment of population number that flow to urban area were the major bottleneck for undertaking appropriate waste management system. This poor waste management and open disposal put several challenges to the well-being of the city residents, particularly those living adjacent the disposal sites due to the potential of the waste to pollute water, foods sources, land, air and vegetables (Beyene and Banerjee, 2011).

According to (Beyene *et al*., 2009, Yukalang *et al.*, 2017), Ethiopia is still struggling to deal with the problem of proper management of solid wastes the development of urbanization MSWM and disposal have been a major problem of municipalities in most of the Ethiopian cities. MSW Collection in the cities is difficult and complex because the generation of residential, commercial and industrial waste is a diffuse process that takes place in each house, building and commercial and industrial facility as well as in the streets, parks and even in the vacant areas available within the community. In addition to this, as stated by (Yukalang *et al.*, 2017)), many cities face problems such as lack of manpower and equipment and financial constraints.

2.4. Composition of Municipal Solid Waste

Urban solid wastes are majorly categorized as biodegradable and non-biodegradable. The biodegradable components of solid waste constitute organic wastes such as food waste, garden waste, and agricultural waste which undergo biological degradation under controlled conditions and can be turned into compost or organic fertilizer. While non-biodegradable wastes include inorganic materials, which can’t be decomposed and degraded (Cheru, 2011a).

The massive area of Bahir Dar city is converted into streets, parking lots, and hotels which increases the amount of solid and liquid wastes disposed to the environment. Household waste represents around 53% of the total MSW produced. Even though waste management and disposal service problems of Bahir Dar have been prioritized, next to housing and flood/drainage problems, 30% to 40% of the waste is still disposed in open places or wetlands, around fences, along streets, in channels, and at the peripheries of water bodies (Fikreyesus *et al*., 2011, Kassie, 2016).

Bahir Dar city solid wastes discharged from the houses contain plastic, wood, paper and cloth (82.5%), metal (3%), food and fruit residuals (7.6%) and others (6.9%) and 26.6% of the household’s burn wastes in their compound, 5.5% dump in a pit, 36.7% dump outside the compound on open space, ditches and roads, and the remaining 0.3% of the households recycle their waste directly. Only 30.9% of the home effluent is collected by the municipality(Kassie, 2016).

2.5. Waste Collection and Transport

Since Dream Light's (Private waste collector) entry into the SWM system of Bahir Dar City in 2008 and the other is 2013, it is the waste generators responsibility to put their mixed waste into any (non-standardized) bags and place them in a designated location on their compound or along the road UNEP. There are controllers who can organize and supervise their collection team to empty the generators waste bags into push-carts or into strong plastic bags and bring them to collection points There, the workers await the dream Light collection truck to empty the bag contents (Lohri *et al.*, 2014).

Table 2. 2.Background information of Micro and Small Enterprises (MSE) of solid waste collectors in Bahir Dar city

No	Name of MSE	Year of establishment	numbers of staff			Services site	Equipment	
			Male	Female	Total		Hand craft	Truck
1	Dream light Plc	2002	4	9	13	Sefeneselam,Tana.Fasilo, Gish abay	16	5
2	Yifetsemal	2005	10	50	60	Hidar 11	7	
3	Sira lehiwot	2005	8	39	47	Shimbit,	6	
4	Green vision	2005	30		30	Shumabo	3	
5	Diresse and their friends	2005	12	44	56	Ginbot 20	3	
6	Emebet,Guadie and their friends	2005	8	32	40	Belay Zeleke	3	
7	Street sweeping	-	-	131	131	Street	14	
	Total		38	339	377		52	5

Source: (Birara and Kassahun, 2018)

2.6. Impacts of Municipals Solid Waste Disposal

It is the fact that, if solid wastes are not managed properly there are many negative impacts on aesthetics, human health, and ecology (water, soil, and air pollution). Therefore, in order to control the management activity in a good manner and have a proactive measure for such a negative impact, one must have a good understanding of the effects and risks that may arise from improperly managed solid wastes.

One of the major environmental impacts of municipal solid waste disposal is the influence of heavy metals in the dumping site. The effects of heavy metals are found to vary with the conditions prevailing in the dumpsites and its binding forms. The open dumpsite being exposed to the atmospheric condition undergoes different effects due to oxygen diffusion. Under high redox condition, the binding of metals to Mn and Fe oxide increases, whereas binding to carbonate, organic compound, and sulfide tend to decrease (Prechthai *et al.*, 2008).

According to (Goa and Sota, 2017), the following are some of the most important effects because of uncontrolled solid waste disposal systems.

- Flies and Mosquitoes breed in some constituents of solid wastes, and flies are very effective vectors that spread disease.
- Waste dumps are the good shelter for rats, it is an agent spread disease, damage electrical cables and other materials.
- Uncollected wastes degrade the urban environment, discouraging efforts to keep the streets and open places in a clean and attractive condition.
- Dangerous items (such as broken glass, razor blades, needles, and other healthcare wastes, aerosol cans, and potentially explosive containers) may pose risks of injury or poisoning, particularly to children and people, who sort through waste.
- Waste items that are recycled without being cleaned effectively or sterilized can transmit the infection to later users.
- Polluted water (leachate) flowing from waste dumps and disposal sites can cause serious pollution of water supplies.
- Waste that is treated or disposed of in unsatisfactory ways can cause a severe aesthetic nuisance in terms of smell and appearance.

- Fires on disposal sites can cause major air pollution, causing illness and reducing visibility, making disposal sites dangerously unstable, causing explosions of cans, and possibly spreading to adjacent property.

In the dry season, when the waste is being burnt, it releases particulate matter such as ash, smoke, dust fumes that contain pollutant gases (oxides of nitrogen, Sulphur, and Carbon). During the rains water that infiltrates through the solid wastes leach the constituents from the decomposed mass and while percolating causes the subsurface to be contaminated by organic and inorganic solutes (Okeke, 2014).

Open dumping of waste is the most prevailing activity practiced by residents of Bahir Dar city and these makes the high probability of environmental pollution, breeding grounds of insects, pests and infectious diseases and also produce toxic gases, which spread odor around the dumping places and block drainage channels (Wegedie, 2018).

Chapter 3. MATERIAL AND METHODS

3.1. Description of the Study Area

This study was conducted in Bahir Dar town which is the capital of Amhara National Regional State (ANRS) in northern Ethiopia. It is located near Lake Tana, the headwaters of the Blue Nile, and is a major tourist destination. It's located at about 565km away from Addis Ababa. The region covers a total area of 152,600 km^2. It has a flat plateau earth structure which is located at 11°36"North latitudes and 37°23" east longitudes. The elevation of the town is about 1801m.a.s.l. The area receives an average annual rainfall ranging between 850mm to 1250mm with the minimum and maximum average daily temperatures of 10^oc and 32^oc, respectively (Kassie, 2016). According to (CSA, 2010) the human population of Bahir Dar city is 220,344 & 47581 households and the estimated population is 360,000 and 52386 households in 2018.

Currently, there is only one open dumpsite, where all collected MSW is disposed of which is known as *Sebatamit* municipals solid waste dumpsite. It is established 15 years ago (2005). It is located in the southeastern part of the city and far apart 3.5 km from the center of the city and which covers 4 hectares' averagely. The dumpsite was commonplace for the disposal of all types of MSW.

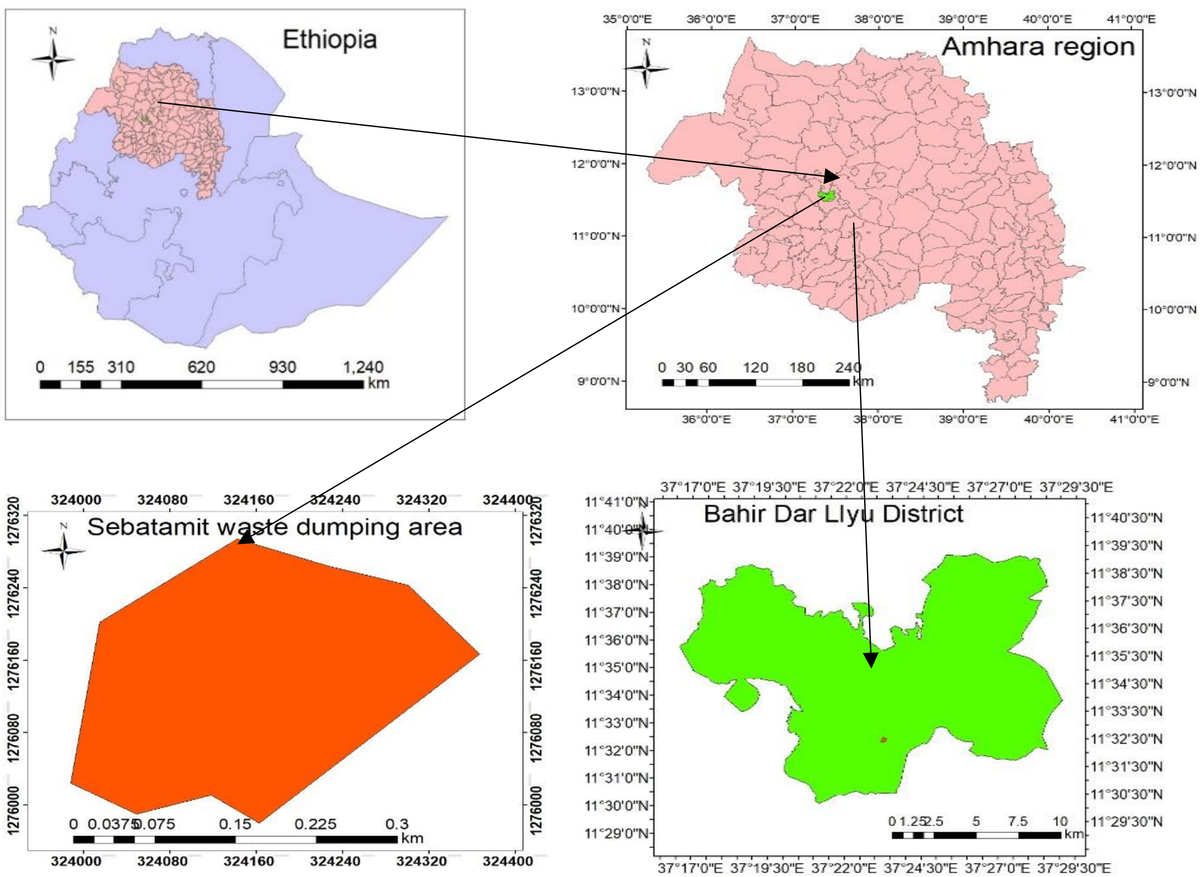

Figure 3. 1. Maps of the study area

3.2. Sampling Techniques and Frame

3.2.1. Samples of household

The required sample size for this study was determined by using the formula developed by (Yamane, 1967) below by considering the level of acceptable margins of error at 5% (or 95% confidence interval): -

$$n = \frac{N}{1+N(e)^2}$$

Where: n is the sample size

N is the size of the total population in the study area

e = Margin of error.

$$n = \frac{52386}{1+52386(0.05)^2} = 397$$

Therefore, the sample size for this study was 397 respondents.

The total sample of the respondent (397) in this study was selected using a purposive and random sampling technique based on population density, commercial activity, and location. With regard to this, the sample of households (HHs) or respondents in each sub-city was selected proportionally (Table 3.1).

Table 3. 1.Sample size

Sub city	Households	Frequency	Percent (%)
Atse Tewodros	8161	62	15.6
Gish abay &Shum abo	8649	66	16.6
Shimbit &Tana	11925	90	22.7
Sefene selam &Fasilo	8002	60	15.1
Belay zeleke	8160	62	15.6
Dagmawi Minelik	7489	57	14.4
Total	52386	397	100.0

Source: CSA, 2010

3.2.2. Soil sampling method

Soil sampling was conducted using a circular plot method. The sample was taken from the depth of 0-25cm and 25-35cm from the center, middle and edge parts of the dumpsite. Three points were selected from one circle and six soil sample was taken from the depth of 0-25cm and 25-35cm in one circle. Similarly, control soil samples were also taken from outside of the dumpsite so as to use for the evaluation of chemical properties of soil. The distance between circle in the dump site was 30metre & between edge of dumpsite and control site circle was 35meters. Then the sample taken in each point was mixed properly based on their recommended depth.

A total of 24 (4*2*3 replications) soil samples were collected in the depth of 0-25cm and 25-35cm including the control site. After collection, the soil samples were taken to Amhara Design and Supervision works enterprise laboratory service soil chemistry laboratory for analysis of pH, Soil Organic Carbon (SOC), Total Nitrogen (TN), Available Phosphorus (AvP), Iron (Fe), Zinc (Zn) and Copper (Cu).

Materials used during soil sample collection was shovel, hoe, hand auger, trowel, bucket, balance and plastic bag. The sample was taken by removing the surface debris and subsurface soil dug to a required depth by hand auger, each sample was immediately placed in a plastic bag and tightly sealed to avoid contamination from the environment.

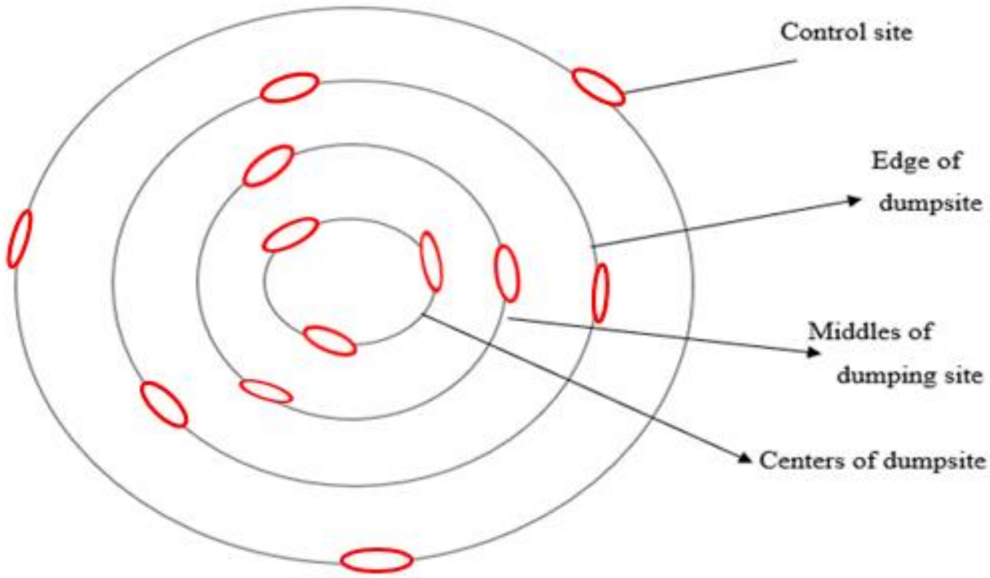

Figure 3.2. Circular plot soil sampling method

3.3. Data Sources

3.3.1. Primary data sources

Observation, photographs, interviews (personal, telephone, e-mail), experimental results, and the semi-structured questionnaire was used as the primary data sources.

3.3.2. Secondary data sources

Secondary data sources were collected from articles, dissertations, newspaper, and different reports from the municipality of Bahir Dar. The data with MSW, human population, demographic structure, altitude, rainfall, topography, temperature, etc. were obtained from the above sources and used for this study.

3.4. Methods of Data Collection

3.4.1. Survey

A survey was done by using a pretested questionnaires and observation checklist. Prior to the starting of data collection, the questionnaire was translated into an Amharic version to make it easily understandable by respondents. The informal approach was used to make the respondents feel comfortable with the questionnaire and to obtain more realistic data. Household characteristics, type of waste, private waste collector, impacts of damping site, transportation, containers used for delivery (transportation, and means of delivery) were identified by the survey. Semi-structured questionnaires containing both open and close-ended questions were administered. The questionnaire was having two parts. The first part of the questionnaire was consisting of questions related to the respondent's profile. The second part of the questionnaire was to incorporate questions related to municipal solid waste management practices.

In addition, key informant interviews (qualitative in-depth interviews with people who know what is going on in the area) were used. Two common techniques (telephone and face-to-face interviews) were used to conduct key informant interviews. Data from secondary sources were obtained by getting permission from concerned officials. The objective of this interview was to solicit ideas that will not be cover by the questioner and for the purpose of triangulation.

Observation: - On top of personal life experiences, field tour to selected areas of the town was carried out the major area of focus include solid waste disposal site located in sebatamit, the roadsides, household storages, and collection systems. This observation and experience acquired from just being a member of the community were helping to assess research questions and objectives.

3.4.2. Laboratory Analysis

The soil samples were collected from the selected site, prepare. and finally analyzed for the determination of the chemical properties of the soil. The samples prepared were air-dried, mixed well, and filtered with 2 mm sieve to make it ready for laboratory analysis.

Soil chemical property analysis: - The chemical characteristics such as pH, soil organic carbon (SOC), Nitrogen (N), Prosperous(P), Zinc, Iron, and Copper was investigated by the analysis procedure of Sahelemedhin and Taye, (2000) in the following method;

Soil pH analyses procedure in water suspension by potentiometry method: -

a) Weigh 10gm air-dried <2mm soil into 100ml beakers.

b) Add 25ml distilled water from a measuring cylinder for distilled water for 1:2.5 Soil/water suspension.

c) Transfer the samples to100ml polyethylene bottles and shake for 2hrs on an orbital shaker in 150rev/min.

d) Allow the solution to stand at least 30minutes.

e) Measure pH on the upper part of water suspension with pH-meter

Soil Organic carbon analysis procedure for visual endpoint titration: -

1. Weigh 0.1-2g air-dry soil (<2mm) and transfer to a 500ml Erlenmeyer flask.
2. Add 10ml 1 N K_2Cr_2O7 solution with pipette to both samples and blank.
3. Carefully add 20ml concentration of H_2SO_4 with measuring cylinder in the fume cupboard and swirl the flask and allow standing on asbestos or cork pad for 30 minutes.
4. Then add 200ml distilled water and allow it to cool.
5. Add 10ml concentration of Orthophosphoric acid and just before titration, add 3ml of barium diphenylamine sulphonate indicator.
6. Titrate both samples and blanks with a 0.5 N ferrous sulfate solution until the color changes to purple or blue, then add ferrous sulfate solution drop by drop until the color flashes to green then continue to a light green end-point.

   % organic matter=1.724*% carbon

   % organic matter=%Total Nitrogen*20

Total Nitrogen analysis procedure by kjeldahl method: -

1. Accurately weigh 1g soil sample (<0.5mm sieve) and transfer it into a digestion tube. For soils rich in organic matter (>10% organic matter) weight in 0.5g. In each batch, include a reference sample and two blanks.

2. Add 2g (1/2 spoon) of catalyst mixture and few carbonrundum boiling stones, mix well and rinse with a little water just enough to moisten the mixture.
3. Add 7 ml of conc.H_2SO_4 and mix by swirling.
4. Place the digestion tube stand with the samples beside the block digester and fit the exhaust manifold on top of it.
5. Place the tubes with rack and exhaust manifold on the digestion block, preheated in the fume-hood.
6. Digest for 3 hours or until the digest is white or pale yellow on a block digester preheated to 380^0C.
7. Allow cooling, and cautiously adding 50ml of distilled water, and then cool again.
8. Transfer the acid digest quantitatively to the macro-kjeldahl flasks and rinse using distilled water.
9. Measure 20ml boric acid solution from a dispenser into a receiver Erlenmeyer flask corresponding to the number of samples. Add to it 2 drops of indicator solution and place under the condenser. Take care that the end of the condenser is immersed in the boric acid solution to prevent any loss of ammonia.
10. Pour 75 ml of 40 percent NaOH carefully down the neck of the distillation flasks containing the digests and mix gently.
11. Fit the prepared 250ml kjeldahl distillation flasks containing the digest to the corresponding holder, close it as soon as possible and start the distillation by heating the flasks containing the digests.
12. When the distillation is complete, i.e. when about 100ml of distillate has been collected, remove the receiver flask. Continue with the next sample.
13. Add a stirrer bar and titrate the receiver flask solution from green to a pink endpoint with 0.1N H_2SO_4. Record the reading of the burette. Transfer the magnet by means of a magnetic rod to the next flask to be titrated. Always standardize the acid to obtain the exact normality of the titrant.

Available Phosphorus analyses procedures by Olsen Method: -

1. Weigh 5 g of < 2mm soil (accuracy 0.01 g) into a 250ml polythene shaking the bottle. Include two blanks and a reference sample.

2. Shake for 30 minutes on a mechanical shaker
3. Filter through a Whatman no. 42 filter paper.
4. If filtrate is not clear, add 1 spoon P-free charcoal, shake again, and filter.
5. Pipette in (short) test tubes 3 ml of the standard series, the blanks and the sample extracts.
6. Slowly add 3 ml of the mixed reagent by pipette and swirl (CO_2 evolution!).
7. Allow the solutions to stand for at least 1 hour for the blue color to develop to its maximum (see remark below).
8. Measure absorbance on spectrophotometers at 882 or 720nm.

Available micronutrients analyses procedures by DTPA Method: -

1. Weigh out 20.0g air-dry soil<2mm in a 100ml polythene bottle. Include one standard sample and two blanks with each series.
2. Add 40.0ml DTPA extractant.
3. Shake for 2hr minutes lengthwise in horizontal position in a reciprocal shaker with a shaking speed of 150 rpm at 20^{O}C.
4. Filter and collect the filtrate.
5. Pipette 10.0ml of the sample extracts, the blank extracts and the working standard solutions of Fe, Cu, and Zn above into test tubes.
6. Add 1 ml of 0.1% lanthanum solution and homogenize.
7. Establish the concentration curve for the working standard solutions containing the lanthanum solution for each of the elements (Fe, Cu, and Zn) by aspirating into the air- acetylene flame and measuring the absorbance or concentration at the following wavelengths.
8. Nebulize the sample extracts and blanks containing the lanthanum chloride solution and record the reading of each of the elements (Fe, Cu, and Zn).

   - The concentration of heavy metals was determined by using the formula developed by (Sahelemedhin and Taye, 2000).

$$\text{Fe, Cu, Zn (mg/kg soil)} = (a-b) \times \frac{40}{S} \times mcf$$

Where:

a= Concentration of (Fe, Cu, or Zn) in the sample extract. (mg/1)

b=Concentration of (Fe, Cu, or Zn) in the blank extract. (mg/1)

40=Volume of air-dry soil g (20g)

S=weight of air-dry soil g (20g)

mcf=moisture correction factor

3.5. Methods of Data Analysis

The result was well interpreted and, the conclusion and recommendation were made subsequently. The survey and soil chemical properties data were coded into the Microsoft Excel spreadsheet. Descriptive statistics such as frequency and percentage were calculated and all the qualitative data were analyzed using SPSS computer software.

The data obtained from laboratory and field measurements were analyzed by using statistical package for social science (SPSS) version 20 software for all the parameters. The least significant difference (LSD) test was used to separate means after the main effects found significant at $p < 0.05$ and linear regression analysis was conducted to quantify some correlations between soil chemical properties. Levels of Chemical properties of dumpsite soil significantly differed from control site soil. The following models were employed for the experiment:

Model

$Y_{ij} = \mu + t_i + b_j + e_{ij}$

Where Y_{ij}= response variable (an observation in i dump site and j control)

μ = the overall mean, t_i= solid waste effect, b_j= depth effect, e_{ij} = random error

Chapter 4. RESULT AND DISCUSSION

4.1. Soil chemical properties

The chemical properties of the dumpsite and outside of dumping site soil pH, Soil Organic Carbon, Nitrogen, Prosperous, Zinc, Iron, and Copper are presented in Table 4.1.

The study revealed that the topsoil pH values of dumpsite (7.89±1.69) and control site (5.74±0.62) were lower than the subsoil of dumpsite (7.96±1.76) and control site (6.26±0.68) which was not in agreement with the study at Addis Ababa city Solid waste dumpsite (Beyene and Banerjee, 2011) and *shashemene* town (Demie and Degefa, 2015). Different factors like leaching action, soil nature, temperature, moisture, mechanical composition and due to the activities of some microorganism on the solid wastes might be responsible for the recorded pH value of soils (Ideriah *et al*., 2006, Okeke, 2014, Goswami and Sarma, 2008). There was a slight difference throughout the depth in both disposal sites and the control site. Other studies also revealed that there are depth-related differences in pH value (Adelekan and Alawode, 2011). It indicates that the soil was acidic which might be a result of chemical absorption in the soil. Low soil pH adversely affects soil microorganisms and also increases the solubility and mobility of heavy metals. Also, higher pH value in both depths was reported in the dumpsite than their controls at Harari town of 8.18 in dumpsite and 6.27 in controlsite (Teka *et al.*, 2018).

Organic carbon decreased with depth (0-25 &25-35) in both dumpsite (2.87±0.32%& 2.56±0.42%) and control site (2.07±0.51% & 1.96±0.83%) respectively. This results because of a decrease in organic matter with depth. The higher value reported for the dumpsite was as a result of the organic component of the municipal waste. The current study was relatively less than to the study at *Maharashtra*, India of mean 4.2 in dumpsite (Deshmukh and Aher, 2017). High organic carbon maybe leads to a high C: N ratio which negatively affects soil fertility. Microbes first utilize the nitrogen and make little available for plant growth.

The mean percentage value of Nitrogen in the dumpsite was 0.98±0.11% for the topsoil and 0.88±0.15% for the subsoil. There also 0.71±0.18% of topsoil nitrogen and 0.67±0.28% of subsoil nitrogen in the control site. The higher value obtained in the dumpsite than the control site can be attributed to the influence of organic matter, organic, and microbial population following the dumping of waste materials. The activities of soil organisms in the decomposition of these wastes may have accounted for the rich in Nitrogen contents of the soil (Obute *et al*., 2010, Amos-Tautua *et al*., 2014). The decrease of nitrogen with depth could be linked to the decrease of organic matter with depth.

The Average value of Available phosphorus dumpsite 28.06±1.33ppm for the topsoil and 27.46±1.78ppm for the subsoil and also Control site values were 22.17±0.65ppm and 21.94±0.44ppm for the topsoil and subsoil respectively. The higher values of phosphorus in the topsoil than subsoil and greater value recorded in the dumpsite can be attributed to the presence of organic matter in the waste.

Heavy metals (Cu, Zn, and Fe) were generally high recorded results in the dumpsite. Mean copper values were 3.15±0.89ppm and 3.21±1.37ppm for the topsoil and subsoil respectively in the dumpsite. The control had topsoil value (2.33±0.60ppm) and subsoil (2.40±0.84ppm). The concentration of copper in both dumpsite and control site high in the subsoil than topsoil and also greater value recorded in dumpsite than control site due to biodegradable waste disposed of into dumping site introduces metallic copper into the soil which was comparable to noticed by the author (Eddy *et al*., 2006). The result also showed that the concentration of copper fell below the other heavy metal (Fe, Zn) concentration. This may be due to the presence of large organic matter content in the sample at this study since copper deficiency is most likely to occur in organic soil (Okeyode and Rufai, 2011, Adamo *et al.*, 2006).

Zinc had average concentrations of 3.73±1.54ppm for the topsoil and 3.67±1.62ppm for the subsoil in the dumpsite. The control had topsoil value (2.82±0.23ppm) and subsoil (2.77±0.20ppm). Comparing the recorded values at dumpsites to control sites, the higher concentration of zinc at dumpsites, and also high value recorded in topsoil than subsoil on dumpsite and control site which was relatively comparable to the study at Harari (Teka *et al.*, 2018).

Iron levels were 9.52±1.47ppm for the topsoil and 9.48±1.65ppm for the subsoil in the dumping site. The control site had topsoil value (6.71±0.42ppm) and subsoil (6.61±0.56ppm). Comparing the recorded values at dumpsites to control sites, a higher concentration of iron at dumpsites could be attributed to the decomposition of iron-containing wastes. There was a slight difference throughout the depth in both disposal sites and the control site or accumulated more iron concentration in the topsoil than the subsoil. Other studies also revealed depth-related differences (Teka *et al*., 2018).

Table 4. 1. Descriptive Statistics (Mean and SD) of the Parameter Values and depth

Parameter	Depth(cm)	Control M±SD	Dumpsite M±SD
pH	0-25	5.74±0.62	7.89±1.69
	25-35	6.26±0.68	7.96±1.76
Soc (%)	0-25	2.07±0.51	2.87±0.32
	25-35	1.96±0.83	2.56±0.42
SOM (%)	0-25	3.56±0.88	4.95±0.55
	25-35	3.37±1.42	4.41±0.73
TN (%)	0-25	0.71±0.18	0.98±0.11
	25-35	0.67±0.28	0.88±0.15
Pav(ppm)	0-25	22.17±0.65	28.06±1.33
	25-35	21.94±0.44	27.46±1.78
Fe(ppm)	0-25	6.71±0.42	9.52±1.47
	25-35	6.61±0.56	9.48±1.65
Cu(ppm)	0-25	2.33±0.60	3.15±0.89
	25-35	2.40±0.84	3.21±1.37
Zn(ppm)	0-25	2.82±0.23	3.73±1.54
	25-35	2.77±0.20	3.67±1.62

level of significance difference with in the parts of dumpsite /treatment was presented in table 4.3.

The chemical properties of soil such as pH, Cu, Zn were significantly different ($p>0.05$) among Edge of dumping site, Middle dumping site, Centers of dumping site, and Control site. Whereas SOC, TN. AvP and Fe were no significantly different ($p<0.05$) among Edges of the dumping site, Middle dumping site, Centers of dumping site, and Control site, but SOC, TN were significantly different ($p<0.05$) among control site and other treatment groups.

Table 4. 2. Level of significance difference with in the parts of dumpsite /treatment

Treatment Dump site	pH	SOC%	SOM%	TN%	AvP ppm	Fe ppm	Cu ppm	Zn ppm
Edges of dumping site	9.84^{a}	2.82^{a}	4.85^{a}	0.96^{a}	28.77^{a}	2.33^{b}	1.81^{d}	8.22^{c}
Middle dumping site	7.23^{b}	2.69^{a}	4.63^{a}	0.92^{a}	28.11^{a}	4.49^{a}	5.36^{a}	8.81^{b}
Center of dumpsite	6.69^{bc}	2.63^{a}	4.54^{a}	0.90^{a}	26.38b	2.70^{b}	3.91^{b}	11.46^{a}
Control site	5.99^{c}	2.01^{b}	3.46^{b}	0.68^{b}	22.05^{c}	2.36^{b}	2.79^{c}	6.65^{d}
p-value	0.000	0.0107	0.0107	0.011	0.00001	0.0001	0.000	0.000
$SE_{\bar{x}}$	0.512	0.218	0.375	0.0759	0.5460	0.3553	0.207	0.186
LSD	16.884	0.779	2.313	0.0934	54.865	6.3207	13.956	24.021
CV (%)	11.93	14.86	14.87	15.09	3.59	20.70	10.36	3.67

$SE_{\bar{x}=}$ Standard of mean; LSD=level of significance difference; CV=coefficient of variance

4.1.1. Pearson Correlations between chemical soil property

Results of Pearson correlation among some parameters chemical properties of soil are presented in Table 4.3.

Total nitrogen was positively and strongly correlated ($P<0.01$) with SOC, it can be attributed to the influence of organic matter, organic waste, and microbial population following the dumping of waste materials. The activities of soil organisms in the decomposition of these wastes may have accounted for the rich in Nitrogen contents of the soil and also soil organic carbon which was comparable to percentages of carbon equivalent to 20 times by percentages of Nitrogen and dived by 1.724 noticed by the author (Sahelemedhin and Taye,2000).

Table 4. 3. Pearson Correlations between chemical soil property

Correlations	pH	SOC	SOM	TN	AvP	Fe	Cu	Zn
pH	1							
SOC%	0.585*	1						
SOM%	0.584*	1.000**	1					
TN%	0.588*	1.000**	1.000**	1				
AvP ppm	0.604**	0.555*	0.555*	0.549*	1			
Fe ppm	-0.533*	0.037	0.038	0.041	-0.474*	1		
Cu ppm	-0.336	0.054	0.054	0.053	0.06	-0.097	1	
Zn ppm	-0.640**	-0.052	-0.051	-0.052	-0.233	0.277	0.806**	1

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

4.2. Survey

4.2.1. Characteristics of respondent

The analysis of household characteristics of respondents revealed that 70.8% were male-headed and the remaining 29.2% were female-headed (Table 4.4). This was due to the fact that most of the time females stay and work inside their house rather than working outside. Besides this, out of the total respondents, 69% of sample respondents belong to the adult age group (26 – 45ages). This is also contributed to the accuracy of the information gathered from such respondents. Furthermore, with respect to marital status, 5.1% of the respondents were married, 7.3% were single,13.6% were divorced and the remaining 4% were widowed.

Table 4. 4. Household characteristics of respondent in study area

Variables	Frequency(N=397)	Percent (%)
Gender		
Male	281	70.8
Female	116	29.2
Age of respondents		
18-25	28	7.1
26-45	274	69.0
over 45	95	23.9
Marital status		
Married	298	75.1
Single	29	7.3
Divorced	54	13.6
Windowed	16	4.0

4.2.2. Socio-economic status of respondent

The socio-economic status of respondents was presented in Table 4.5. The educational status of respondents disclosed that about 0.3%, 0.3%, 1.3%, and 9.6% of households were attended with a grade of 1-4, 5-8, and 9-10, respectively. Similarly, about 36.5%, were attended under grade 11-12 whereas the remaining 52.1% were attended under college and universities. The occupation of the respondents shows that 48.4% were government employees, 20.7% were engaged in private organizations, 11.8% were self-employed; about 13.4% were merchants, 5.3% were housewives and the remaining 0.5% were had others work. The family sizes of respondents in this study were 3-4 families 49.1%, 1-2 families 28.2%, 5- 9 families 22.4% and >10 families 0.3% are found in the HHs.

Table 4. 5. Respondent's educational level, occupation and family size

Parameters	Frequency (N=397)	Percent (%)
Educational level		
No formal Education	1	0.3
1-4 grade complete	1	0.3
5-8 grade complete	5	1.3
9-10 grade complete	38	9.6
11-12 grade complete	145	36.5
College /university	207	52.1
Occupation		
Government	192	48.4
Private sector	82	20.7
Self Employed	47	11.8
Merchant	53	13.4
House wife	21	5.3
Other	2	.5
Family size		
1-2	112	28.2
3-4	195	49.1
5-9	89	22.4
10 and above	1	0.3

4.2.3. Characteristics of municipals solid waste

Types of MSW generated in the study area: - Types of MSW generated in the study area were presented in Table 4.6. Accordingly, the sample households were asked about the types of solid waste mostly produced from their house, and 27.7% responded Paper, glass, cosmos, fines, and plastic, 24.4% responded Chemical, bottle, bone, old cloth, plastic, and ash; 19.4% responded Fruit residual, Ash, glass, plastic and Garden trimming; 15.1% responded Fruit residual, Ash, glass, plastic, and Garden trimming or leaves and 13.9% responded Bone, old cloth, plastic, and

Fruit residual wastes are mostly produced from their houses. The current study was relatively comparable with the study at *wolkite* (Hailu *et al*., 2019) and at Bahir Dar (Kassie, 2016).

Table 4. 6. Types of MSW generated in Bahir Dar city

Parameter	Frequency (N=397)	Percent (%)
Types of waste		
Fruit residual, plastic, bone, metals and ash	60	15.1
Chemical, bottle, bone, old cloth, plastic and ash	97	24.4
Paper, glass. cosmos, fines and plastic	108	27.2
Fruit residual, Ash, glass, plastic and Garden trimming or leaves	77	19.4
Bone, old cloth, plastic and Fruit residual	55	13.9

The Physical composition of MSW: it is a term usually applied to a various mixture of solid waste produced in urban areas. But commonly urban waste can be subdivided into two major components called biodegradable and non-biodegradable. The biodegradable component of urban solid waste constitutes organic waste such as food waste, garden waste, agricultural waste which undergoes biological degradation under controlled conditions and can be turned in to compost or organic fertilizer. While non-biodegradable wastes include inorganic materials, which can't be decomposed and degraded, the current study was comparable to the study at Addis Abeba (Cheru, 2011b) and *Wolkite* town (Hailu *et al*., 2019).

4.2.4. Solid waste management practices in Bahir Dar town

Solid waste storage facility and its handling: - Studying solid waste storage facilities and their handling has a significant impact on the betterment of municipal solid waste management activity. Identification of type of storage material to be used, deciding the collection method to be used, and avoidance of adverse impacts of storage materials.

Temporary solid waste storage and storage material of respondents were presented in Table 4.7. From the total respondents, 99% of respondents had temporary solid waste storage material in their house, while the remaining 1% of sample respondents do not have temporary solid waste storage material.

Residents of Bahir Dar used different types of storage materials in their compound which is sacks local name of “*Madaberia*”, plastic containers local name “*Festal*” and others. This is highly related to the least cost of a sack, easy availability in the market, its suitability for holding a large volume of solid wastes and easily delivered by MSEs of the City. The result has shown that 97.5% of sample respondents were used sacks local name of “*Madaberia*” and plastic container (*festal*) about 0.8%, and while the remaining 1.8% used other storage materials, which was relatively comparable to the study at in *Jigjiga* town 99.1% respondents were used sack as solid waste primary storage materials in their house (Birhanu and Berisa, 2015).

It is also observed that most of the households who use the "*Festal*", as a storage material for their solid waste at home, throw it away together with the waste it contains. This experience of the households shows that storage materials are meant one-time use only. This means that no more value is given for the storage materials once they are used for waste storage and, very soon, the storage materials become part of the waste that increases the quantity of non-decomposable solid waste that increasingly littering most part of the city in general. However, one way to manage solid waste is to reduce the waste we generate at the source and hence storage materials have to be designed for many times use so that these items do not wear out so quickly and become part of waste instead.

Table 4.7. Solid waste storage material used in the house households

Parameters	Frequency(N=387)	Percent (%)
Temporary Solid Waste Storage		
Yes	393	99.0
No	4	1.0
Types of storage material		
Sack	387	97.4
Plastic container('*festal*')	3	0.8
Other	7	1.8

Solid waste separation process and recovery activity: -In this study, solid waste separation, processing, and recovery activities at source and by a municipality refer all activities or efforts of separation of recyclable, reusable, compostable wastes to sell or to recover resources by themselves. Practicing these types of activities is very important to waste generators as well as a municipality since it minimizes the cost of disposal, generates revenue, and prolongs the lifespan of the disposal site.

Household waste separation practices were presented in Table 4.8. From a total of 397 respondents, 87.7% didn't separate solid wastes and only 12.3% practices solid waste separation which were relatively comparable to the study at Bahir Dar (Wegedie, 2018).

A subsequent question also asked those respondents that the reason behind not practicing waste separation. Based on the question, respondents gave their respective answers as 19.5% told that they do not have an understanding about waste separation; 31.9% told that they do not visualize the importance of separation; 45.1% believe that waste is not their responsibility and 3.4% told that there is no answer, this study was comparable to the study at Bishoftu City (Endalkachew, 2018).

The researcher observed from households‟ solid waste separation activities in the city, only solid wastes that are sold to "*Quraleos*" and exchangeable to "*Liwach*" are separated. The Response of sample households also showed that about 26.5% of they are separately stored solid wastes which are sold to "*Quraleos*" and exchangeable with "*Liwach*", 59.2% of them are separately stored solid wastes which are to helps waste collectors (to make collection easier/reduced-hazard). The current study, which was comparable to the study at Bahir Dar (Wegedie, 2018).

Table 4. 8. Household waste separation practices

Parameters	Frequency(N=397)	Percent (%)
Practice of Waste Separation at Household Level		
Yes	49	12.3
No	348	87.7
Total	397	100
Purpose of separating Waste at Household Level		
To reuse	7	14.3
To sell / exchange	13	26.5
To help waste collectors (to make collection easier/reduced hazard)	29	59.2
Total	49	100
Reasons for not Separating Waste		
I do not have understanding about waste separation	68	19.5
I did not think as it is my responsibility	157	45.1
I did not visualize the importance of separation	111	31.9
Other	12	3.4
Total	348	100

Solid waste collection and transportation system: - Door to door solid waste collection and transportation systems are largely implemented for the collection of solid waste from residential areas. The responsibilities of the solid waste the collection is entrusted to the city “SBPDD”. The department was responsible for the overall solid waste management in the city collect door to door wastes collector and the other who operates the street sweeping.

The frequency of the collection services rendered by MSEs and the willingness of households to pay for the service of solid waste management presented in Table 4.9. Therefore, the result revealed that 5.5% reported that MSEs collect solid wastes on a weekly basis, 0.3% twice in a week, 6.3% wastes on a monthly basis, 62.2% in three weeks and the remaining 4% of the respondents said that MSEs collect solid wastes on twice a month.

The respondents in the study area were assessed on their willingness to pay to improve solid waste management and the responses of majority participants were 98% were actually willing to pay to improve the waste collection services. Only 2% of respondents replied that they were not willing to pay for solid waste management services. Therefore, based on the findings of the study almost all the respondents are willing to pay for the service of solid waste management. In the same way (Lohri *et al*., 2014) noticed that Each household is required to pay a monthly flat fee to the fee collectors of the private waste company who go from door-to-door to collect it in cash.

Table 4. 9. Households that get service from MSEs and Willingness to pay

Parameters	Frequency(N=397)	Percent (%)
Frequency of MSEs Collection		
per Week	22	5.5
Twice a week	1	0.3
In three Week	247	62.2
Twice a month	102	25.7
Monthly	25	6.3
Respondents Willingness to Pay to MSEs to improve SWM service		
Yes	389	98.0
No	8	2.0

Solid waste disposal practices:- the study disclosed that in Table 10, about 81.6% of the respondent waste disposed of by MSEs, 1.8% of respondents disposing of by digging a hole around the house and burn it; 15.1% of respondents disposing of by throwing it on open space, in sewerage or on street, 1.3% respondents use by disposing on the backyards of their house, and the remaining 0.3% of respondents use other means of disposing of methods like using for the daily laborer. The response of sampled households strongly reflected the poor awareness of the community about the close relationship existing between solid waste and their environment & health. This was due to the fact that little effort made by the concerned body to give health and environmental education so as to create awareness among the people.

Table 4. 10. Alternative means of households to dispose of their solid wastes

Parameters	Frequency(N=397)	Percent (%)
Means of Solid Waste Disposal Available for Households		
Throw it on an open space, in sewerage or on street	60	15.1
Digging a hole around the house and burn it	7	1.8
Disposing on the backyards of the house	5	1.3
MSEs take it	324	81.6
Others	1	0.3

4.2.5. Public awareness, attitude, perception and participation

Households Opinion, attitude, and perception about Solid waste presented in Table 11.
Among the total households, 40.1 % of them were stated that somewhat useful whereas 35.5% stated that solid waste was totally useless, again 13.9 % were also stated solid wastes were useful and the remaining 10.6% of respondents did not know about waste. Similarly, the vast majority 94% of the respondents agree on the issue of proper management of household solid wastes.

Table 4. 11. Households opinion, attitude and perception about solid waste

Parameters	Frequency(N=397)	Percent (%)
Opinion of respondents on the use of solid wastes		
Useful	55	13.9
Somewhat useful	159	40.1
Useless	141	35.5
Do not know	42	10.6
Opinion of respondents on the importance of appropriate waste handling practices		
No	24	6.0
Yes	373	94.0

Enforcement of Rules and regulations on solid waste management was presented in Table 12. Solid waste management related rules and regulations derived from hygiene and environmental health regulation of Amhara regional state adopted in 2000 and 2002 and Federal Democratic Republic of Ethiopia municipals solid waste management proclamation No 513/2007. These rules and regulations are largely emphasized on solid waste handling responsibilities and obligations of persons, establishments, and institutions. Apart from this there is also low enforcement. From a total of 397 respondents, 87.4% the follow – up on rules and regulation in the city is none at all and 12.6%, the regulation is a week and this implies that related to waste disposal and environmental protection issues the municipality intervention is really low. It implies that they did not observe any penalty related action, which is taken by the municipality because of illegal solid waste disposal. The current study was comparable to the study at Addis Abeba (Mohammed and Elias, 2017), noticed that the SWM strategy mentions lack of strong political commitment for SWM; challenges to streamline existing legal and regulatory frameworks; absence of mechanisms that would ensure inter-institutional collaboration; limited managerial and technical competencies in municipal SWM operations; and lack of service delivery standards as gaps in waste management.

Out of the total respondents, 99.7% of respondents didn't see when the violators penalized and the rest 0.3% of respondents seen when the violators are penalized. The current study was relatively comparable to the study at Gondar town 97.57% of respondents didn't know rule and regulation related to SWM venality (Mohammed,2015). From this one can understand that since awareness creation on the existence of solid waste laws and regulation and its enforceability and solid waste management is very poor, it is one of a serious cause or constraint for the performance of solid waste management in the study area, which was comparable to (Kassa, 2009), noticed that, there are no clear rules and regulations pertaining to SWM apart from general guidelines, an approach that is not effective at all.

Table 4. 12. Enforcement of Rules and regulation on solid waste management

Parameters	Frequency(N=397)	Percent (%)
Respondents Evaluation on the Follow up by the Responsible Bodies to practice the Rules and Regulations of Solid Wastes Disposal in the Location		
Regulation is strong	0	0.00
Regulation is week	50	12.6
None at all	347	87.4
Respondents Opinions on Penalization of Violators is SWM Rules and Regulations in the Location		
Yes	1	0.3
No	396	99.7

4.2.6. Impacts of *Sebatamit* dumping site

The Impacts of the dumping site on the community were presented in Table 13. The impacts of dumping site on the community disclosed that about 32.7% of them stated that it has the impacts on public health problem (respondent within study area explained that they were facing difficult impact and unpleasant smell which leading to different respiratory health problems like asthma, frequent coughing, stomachache, and headache, this was in line with the study at *Digotsion* town (Maru,2014), noticed that waste dumping sites causes infections (like common cold, asthma, headaches), bad odor, flies and mosquitoes causing diarrhea, and malaria and *shashemene* town (Demie and Degefa, 2015), noticed that waste dumping sites attract flies, rats. dog and other creatures that spread diseases to the communities around dumpsites. About 30.7% of respondents were also stated to affect public health problems and animal health problems,15.4% were answered the environmental problem,12.8% of them are said animal health problems, and the other 8.3% of respondents were stated that it has the impacts on public health problem and environmental problem. In light of this, studies show different results such as (Prechthai *et al*., 2008) observed that the effects of heavy metals are found to vary with the conditions prevailing in the dumpsites and its binding forms. The open dumpsite being exposed to the atmospheric condition undergoes different effects due to oxygen diffusion and during burning release pollutants to the environment (Appendix figure 6). The current study, which was comparable to the study at Addis Abeba city (Regassa *et al.*, 2011) noticed that open-air burning and spontaneous combustion in the dumping site, are among the causes of air pollution and unpleasant odor. The dumpsite has some advantages such as compost preparation and pig farms.

Table 4. 13. The Impacts of dumping site on the community

Parameters	Frequency(N=397)	Percent (%)
The impacts of sebatamit dumping site		
Public Health problem	130	32.7
Environmental problem	61	15.4
Animal health problem	51	12.8
Public Health problem and Animal health problem	122	30.7
Public Health problem and Environmental problem	33	8.3

The consequences of dumping site impact on daily activity were presented in Table 4.14. About 38.8%delaying of daily activity due to get clinical treatment and treating them, 27.5% of respondents express that wastage time, 23.9% of respondents responds that wastages of many by buying medicinal things to treat themselves and 9.8% of respondents stated that it has the consequences wastage of time, wastages of money and delaying of daily activity due to get clinical treatment.

Table 4. 14. The consequences of the dumping site impact on daily activity

Parameters	Frequency(N=397)	Percent (%)
The consequence of the impact in the house hold level		
Wastage of time	109	27.5
Wastages of money	95	23.9
Delaying of daily activity due to get clinical treatment	154	38.8
Wastage of time, wastages of money and Delaying of daily activity due to get clinical treatment	39	9.8

Chapter 5. CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusion

The objectives of this study were to Examine the impacts of municipal solid waste disposed on soil chemical properties within the dumpsite and surrounding environment, Investigate the municipals solid waste management system of Bahir Dar and Assess the perception of communities on dumping and its associated health and environment impact. Accordingly, municipals solid waste had varying effects on the chemical properties of soil such as total nitrogen, soil organic carbon, available phosphorus and heavy metals are higher in the polluted area than the control area.

- Higher pH value, total nitrogen, soil organic carbon and available phosphorus were recorded in the dumpsite than the control site.
- Higher concentration of iron was recorded than the other heavy metals at dumpsite than control site and also high value was recorded in topsoil than subsoil.
- Higher concentration of zinc and copper was recorded in the dumpsite than the control site in both depths.
- Most of the waste generated through HHs in the area were paper, glass & bottle, cosmos, fines, bone, plastics, fruit residue and garden trimming.
- Majority of respondents were used sack and plastic for temporary solid waste storage material in their house and among these 12.3% of respondents practice waste separation for helping the collectors to pick the waste easily. From the generated waste, about 62.2% of HHs waste was taken by the MSEs in three weeks and 25.7% of HHs waste was taken by the MSEs in two weeks.
- Most households feel that the lack of stiff penalty and non-execution of law is the basic problem for the effective management of waste. It is found that environmental awareness is very low among the residents of the city.
- The solid waste management practices in the city is poor or week.
- The improper municipal solid waste management had a potential risk to human health, animal health and environment.

5.2. Recommendation

The main finding of this study showed that continuous application of all categories of solid waste and inappropriate solid waste (open landfill) disposal system on land resulted from degraded quality of the soil, environmental and public health problem by the accumulation of metals in receiving soils and release of concentrated leachate to the environment which further become a potential source of entry into the food chain. Currently, there is no pollution control method being practiced at the specific disposal site. Hence, the authors recommend that; -

- The area (open landfill) should be closed and treated to minimize the impact of toxic heavy metals by application of different remedial action like phytoremediation and bioremediation so as reduce the rate of contamination and future cumulative pollution problems.
- The present dumpsite is treated accordingly to minimize the impact of persistent heavy metals in the area to be used for further economical use of the land.
- The city administration should focus on integrated waste management technologies and increasing the capacity of the informal sector participating in waste management.
- Institutional capacity building must also be considered. A strong networking system within the sub-cities is also required to facilitate information flows.
- The legal frameworks must also be put in place along with effective enforcement mechanisms to implement the laws and policies.
- Penalties should be practiced on those who didn’t obey the laws. Enhancement of the participation and role of NGOs, private sector, and communities must also put in place.

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7.APPENDIXES

Appendix Table 1. Laboratory results of soil chemical property

Amhara Design & Suppervison Works Enterprise
Leaboratory service
Soil Chemistry & Water quality Section

አማራ የዲዛይንና ቁጥጥር ስራዎች ድርጅት
ላቦራቶሪ አገልግሎት
የአፈር ኬሚስትሪ ና ዉሃ ጥራት የስራ ክፍል

Soil Analysis of laboratory report
Client : Yonase Ayitenew (BDU) ;

No.	Lab. No.	Treatment	Depth (cm)	Replic.	Code	pH (H_2O)	SOC	SOM	TN	Av.P	Fe	Cu	Zn
							%			ppm			
1	1901/20	Centers of dumpsite	D1 (0-25)	R1	SDSD1R1	6.64	2.59	4.46	0.89	26.18	11.1	2.96	4.15
2	1902/20	Centers of dumpsite	D1 (0-25)	R2	SDSD1R2	6.66	2.78	4.79	0.95	27.17	11.3	3.04	3.89
3	1903/20	Centers of dumpsite	D1 (0-25)	R3	SDSD1R3	6.58	2.8	4.82	0.96	25.87	11.7	2.87	4.04
4	1904/20	Centers of dumpsite	D2 (25-35)	R1	SDSD2R1	6.71	2.16	3.72	0.74	25.92	11.1	1.24	3.31
5	1905/20	Centers of dumpsite	D2 (25-35)	R2	SDSD2R2	6.8	2.73	4.7	0.94	27.28	11.7	3.15	3.67
6	1906/20	Centers of dumpsite	D2 (25-35)	R3	SDSD2R3	6.78	2.76	4.75	0.95	25.9	11.9	2.98	4.43
7	1907/20	Middles of dumpsite	D1 (0-25)	R1	MDSD1R1	7.24	2.98	5.13	1.02	29.08	9.04	4.54	5.87
8	1908/20	Middles of dumpsite	D1 (0-25)	R2	MDSD1R2	6.87	2.78	4.79	0.95	28.63	8.96	4.09	4.98
9	1909/20	Middles of dumpsite	D1 (0-25)	R3	MDSD1R3	7.45	3	5.17	1.03	29.14	9.00	3.97	5.06
10	1910/20	Middles of dumpsite	D2 (25-35)	R1	MDSD2R1	7.57	2.41	4.15	0.83	25.14	8.28	5.41	5.49
11	1911/20	Middles of dumpsite	D2 (25-35)	R2	MDSD2R2	6.44	2.43	4.18	0.83	28.65	9.02	4.87	5.00
12	1912/20	Middles of dumpsite	D2 (25-35)	R3	MDSD2R3	7.86	2.56	4.41	0.88	28.07	8.6	4.07	5.76
13	1913/20	Edges of dumpsite	D1 (0-25)	R1	EDSD1R1	8.12	2.32	3.99	0.79	28.16	7.68	2.08	1.62
14	1914/20	Edges of dumpsite	D1 (0-25)	R2	EDSD1R2	11.04	3.23	5.56	1.11	29.05	8.05	1.9	1.87
15	1915/20	Edges of dumpsite	D1 (0-25)	R3	EDSD1R3	10.45	3.37	5.8	1.16	29.25	8.84	2.86	2.05
16	1916/20	Edges of dumpsite	D2 (25-35)	R1	EDSD2R1	7.83	1.93	3.32	0.66	26.41	7.24	1.86	1.49
17	1917/20	Edges of dumpsite	D2 (25-35)	R2	EDSD2R2	11.78	3.43	5.91	1.18	29.45	8.56	2.32	1.97
18	1918/20	Edges of dumpsite	D2 (25-35)	R3	EDSD2R3	9.83	2.65	4.56	0.91	30.32	8.97	2.96	1.87
19	1919/20	Control site	D1 (0-25)	R1	CSD1R1	5.11	1.69	2.91	0.58	22.09	6.32	1.68	2.87
20	1920/20	Control site	D1 (0-25)	R2	CSD1R2	6.34	2.65	4.56	0.91	21.56	6.65	2.45	3.02
21	1921/20	Control site	D1 (0-25)	R3	CSD1R3	5.76	1.87	3.22	0.64	22.86	7.15	2.87	2.56
22	1922/20	Control site	D2 (25-35)	R1	CSD2R1	5.49	1.26	2.17	0.43	21.48	5.96	1.44	2.74
23	1923/20	Control site	D2 (25-35)	R2	CSD2R2	6.76	2.87	4.94	0.98	22.00	6.88	2.72	2.98
24	1924/20	Control site	D2 (25-35)	R3	CSD2R3	6.53	1.74	2.99	0.59	22.35	6.98	3.03	2.59

Name Of Chemist ______ Checked by ______ Approved by ______
Date 08/05/2012 Date ______ Date ______
Sign ______ Sign ______ Sign ______

Appendix Figures 1.Physical Composition of MSW in the dump site

Source: Researcher field observation

Appendix Figures 2. Waste storage materials /sack /Madaberia their house

Source: Researcher field observation

Appendix Figures 3. Waste collector/ MSE/ during waste collection

Source: Researcher field observation

Appendix Figures 4. Thrown waste on road around respondents' home

Source: Researcher field observation

Appendix Figures 5. Waste feeder animal and causes of transmissions disease to human

Source: Researcher field observation

Appendix Figures 6. Burning of waste in dumping site and release gases into environment

Source: Researcher field observation

Appendix of Questioners

BAHIR DAR UNIVERSITY

COLLEGE OF AGRICULTURE AND ENVIRONMENTAL SCIENCE DEPARTMENT: NATURAL RESOURCE MANAGEMENT

This HH questionnaire aims at examining perception of local community on sebatamit dumping site & solid waste and it primarily intended for academic purpose. Thank you in advance for your genuine information.

Instructions: -

Please tick in the appropriate box and also fill in the blank spaces provided for those questions where elaborate answers are required. Please do not include your name on the questionnaire. Participation will be voluntary and information will be used for research only. Kindly spare your time to provide answers as honestly and objectively as possible.

Questionnaire prepared for sample households in Bahir Dar City Administration

Sub city / *Kebele* ___________ Code ________________

Section One: Socio demographic characteristics of the respondent

1. Sex: A. Male B. Female

2. Age: A. 18 - 25 B. 26 - 45 C. over 45

3. Educational Status:

A. No formal education B.1-4 grade complete

C. 5-8 grades complete D. 9-10 grades complete

E. 11 – 12 grades complete F. College / University

4. Marital Status:

A. Married B. Single

C. Divorced D. Widowed

5. Occupational Status:

A. Government B. Private sector

C. Self-employed D. Merchant

E. Housewife F. Other

6. Family size:

A. 1-2 B. 3-4

C. 5-9 D. ≥ 10

7. Average monthly income of household (in birr):

A. < 1000 B. 1000 – 2000

C. 2000-3000 D. > 3000

Section Two: Questions Related with Solid Waste Management Practice (Type, Storage, Collection and Disposal)

1. What kinds of the household wastes are mostly produced from your house? (More than one answers possible)

A. Peels of Vegetables B. Ash

C. Paper and cardboard D. Plastic

E. Garden trimmings or leaf F. Other

2. Do you have a temporary solid waste storage in your house?

A. Yes B. No

3. What type of solid waste storage material do you use in your house to store solid wastes?

A. Bamboo basket

B. Sack

C. Metal container

D. plastic container (festal)

E. Other ____________

4. If No for question no 3, how can you store solid wastes or how you come across with the problem of solid waste storage? ----------------------

5. Do your household practice waste separation?

A. Yes B. No

6. If your answer for question no 5 is „Yes‟, for what purpose do you separate those wastes?

A. To reuse B. To sell / exchange

C. To present as a gift to others D. To recycle

E. To help waste collectors (to make the collection easier)

F. Other, specify:……

7. If your answer for question no 5 is No‟, what do you think the reason behind?

A. I do not have the understanding about waste separation

B. I did not think as it is my responsibility

C. I did not visualize the importance of separation

D. if any other reason, please specify it

9. Do you have a say or participation in deciding the location /placement of the public container?

A. Yes B. No

10. What other means do you use to dispose solid wastes of your household?

A. Throw it on an open space, in sewerage or on street

B. Digging a hole around the house and burn it

C. Disposing on the backyards of the house

D. Private collectors take it

F. Others, please specify__________________________

11. How often do you empty your wastes to either of your choice dumping place?

A. Everyday B. Every 2 to 3 days

C. Every week D. Every two weeks

E. Once a month F. Others: __________

12. What time do you prefer to dispose your household wastes?

A. Early morning B. Late morning C. Afternoon

D. Early night E. the time of private waste collectors

13. Do you use informal sectors such as daily workers, laborers, beggars, mentally retarded people or others for door to door solid waste collection from your residence?

A. Yes B. No

14. If your answer for question no 13 is „yes‟, how much do you pay for the service render per month, and specify solid waste service provider criteria for fixing your charge.

____.

15. Do you have access to door to door solid waste collection service delivered from the MSEs? (If No, go to question No 14)

A. Yes B. No

16. What do you think is the current number of private wastes collectors (MSEs)? Do you have enough access to them?

A. Enough access B. Not enough access C. None at all

17. How long have you been getting the service? A. < 1-year B. 1-2 years C.>=3 years

18. If your answer for question no 13 is „Yes‟, How often do the private MSEs collect solid waste from your house?

A. Twice a week B. Weekly C. Twice a month

D. monthly E. Indicate if any other arrangement: ____________

19. How much do you pay for the MSEs Services, indicate in birr? -----------

20. What do you do with the solid waste from your household if the MSEs did not come at the right time and find your temporary storage full? (More than one answer possible)

A. I keep the waste at home until the collectors are coming

B. I burn it in the back of my home

C. I dump it on open space, which is far from the main road

D. I dump it in sewerage

E. Other

21. To what extent the MSEs discharge their responsibility?

21.1 Treating all households equally A. Yes B. No

21.2 Have adequate capacity to serve the given place/ household A. Yes B. No

21.3 Have required skill to collect and manage household wastes effectively A. Yes B. No

21.4 Collect wastes from households at the right / needed time A. Yes B. No

21.5 The payment they receive from household is fair A. Yes B. No

21.6 Generally, they are committed in providing their services A. Yes B. No

22. If you are not getting the MSEs Services, do you believe that the location of your home/village/ is one factor to prevent you from such services?

A. Yes B. No

23. What do you think the main reasons why you did not get the MSEs waste collection services? (Only for HHs not engaged in the service)

Section 3: Attitudes and Awareness towards Solid Waste Management

24. How do you think of solid wastes? Do you think solid wastes are?

A. Useful B. Somewhat useful

C. Useless D. Do not know

25. Do you agree with the importance of appropriate waste handling?

A. Yes B. No

26. Who do you think is responsible for solid waste management? (More than one answers possible)

A. The municipality B. The private waste collectors

C. The households D. Other

27. How do you evaluate the efforts of made so far by the municipality of the city to provide solid waste management services?

A. Very good B. Good

C. Fair D. Bad

28. Do you know that there are rules and regulations of solid wastes in Bahir Dar city?

A. Yes B. No

29. How do you evaluate the follow – up by the responsible bodies to practice the rules and regulations of solid waste disposal in Bahir Dar?

A. Regulation is strong B. Regulation is weak C. None at all

30. Have you ever seen when violators of regulation in solid waste management are penalized?

A. Yes B. No

31. If your answer for question No. 30 is “yes”, how do you evaluate the appropriateness of the penalty to prevent violators of solid waste management rules and regulations?

A. Very strong B. Strong

C. Fair D. Weak E. Very week

32. Have you ever obtained education, training or information about solid waste management?

A. Yes B. No

33. If your answer for question No. 32 is “YES”, who provide the information?

A. Municipality B. Kebele

C. Learn by yourself D. NGO E. Other

34. Would you be interested to learn more about solid waste management, environmental impact of waste, and various ways of minimizing and treating the waste stream?

A. Yes B. No

35. If so, what would be your favored method of increasing your knowledge?

A. In general meeting of the town B. In kebele meeting

C. In Idir meeting D. if any other________________________

36. How is cleanup campaigns frequent in your kebele?

A. Rare B. Weekly

C. Monthly D. I do not know such campaign exists

37. Have you ever participated in a cleanup campaign in your kebele?

A. Yes B. No

38. If your answer for question no 37 is “yes”, how many times you participate in the last year________________.

39. Have you ever provide any complain to the municipality when the private waste collectors did not come in your household at the right time? (only for HH who use MSEs)

A. Yes B. No

40. If your answer for question number 40 is “No”, what action did you take to solve such problem? ------------------

41. Are you willing to pay for the private waste collectors‟ service in order to improve solid waste disposal practice in your town?

A. No B. Yes

42. How many years these sebatamit waste dumping site established for waste disposal?

43. What is the impacts of sebatamit dumping site?

A. Health problem
B. Environmental problem
C. Animal health problem
D. Others

44. If you answer for Q 43, what is the consequence in your family

A. wastage of time B. wastages of money

C. Delaying of daily activity due to get clinical treatment

45**.** Do you communicate to the responsible body to alleviate the occurred problem? ----and recommended solution…………….

46. If you have any additional comments, suggestions about sebatamit waste dumping site or would like to elaborate on any of your previous answers------------------------------------

"Thank you very much"!!!

BIOGRAPHICAL SKETCH

The author was born to his father Mr. Ayitenew Getnet and his mother Mrs. Kibebe Tsehay in February, 23/02/1988, in Dimma Enemay Woreda East Gijjam Zone of Amhara Region. He started his elementary school in 1995 at Dimma Elementary School and he attended his Secondary High School education at Belay Zeleke General Secondary School & Preparatory School education at Belay Zeleke Preparatory School and he took ESLCE in 2007. Then he joined Debre Markos University, College of Agriculture and Environmental Science in 2007 Department of Natural Resource Management and graduated with BSC of Natural Resource Management in July 5/2010. Then after he was employed by Debay Tilatgin woreda agriculture office in October, 17/10/2010 and served for five year up to April 2015 as a soil and water conservation expert and now he was employed by Bahir Dar Polly technic college in May 2015. Then he joined the School of Graduate Studies, of Bahir Dar University College of Agriculture and Environmental Science in October 2018 regular program to pursue his MSc. study in Environment and climate change.