AN ASSESSMENT OF WASTE MANAGEMENT PRACTICES OF ZARIA INDUSTRIES NIGERIA LIMITED, ZARIA, KADUNA STATE, NIGERIA

BY

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A Dissertation Submitted to the School of Post Graduate Studies, Ahmadu Bello University Zaria in Partial Fulfillment for the Award of a Master of Science in Environmental Management.

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FACULTY OF SCIENCE,

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ZARIA.

NOVEMBER, 2015.

DECLARATION

I declare that the thesis entitled "Assessment of Waste Management Practices of Zaria Industries Nigeria Limited, Zaria, Kaduna State, Nigeria" has been written by me in the Department of Geography under the supervision of Prof. E.O. Oladipo and Dr. R. O. Yusuf. The information derived from the literature has been duly acknowledged in the text and a list of references provided. No part of this project thesis was previously presented for another degree or diploma at any other university.

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CERTIFICATION

This thesis entitled "Assessment of Waste Management Practices of Zaria Industries Nigeria Limited, Zaria, Kaduna State, Nigeria" by Robert Terhemen ANGER meets the regulation governing the award of the Degree of Masters of Science Environmental Management in Ahmadu Bello University, and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

This thesis is dedicated to the Almighty GOD, who saw me through to the completion of the programme.

To my beloved parents, Mr. and Mrs. Anger, who gave me all the spiritual and moral support. I will always live to remember your love and care.

I also dedicate this project to my wife, Joy Robert, my son, Mfena Robert, and Brothers most specially Mr. Bako A. G. my big Brother and friend, Dr. R. O. Yusuf, and all those that contributed in one way or the other to the manifestation of this thesis.

ACKNOWLEDGEMENT

I sincerely give God all the glory, and praise for the grace given to me throughout the duration of this postgraduate programme.

I wish to express my profound gratitude and appreciation to my supervisors Prof. E.O. Oladipo and Dr. R. O. Yusuf for their patience and guidance in seeing to the completion of this work. I also wish to appreciate the entire departmental team and colleagues especially Mal. Lawal, Dr. Kibon U. A., Dr. Musa I. J., Mr. Bako A. G., Mrs. Damilo, R., for their support, prayers and encouragement in this race.

Thanks and God bless you all.

ABSTRACT

Proper management of effluent waste has multiple socioeconomic and environmental benefits that have not been adequately examined in Zaria Industries Nigeria, Limited, Zaria, Kaduna State, Nigeria. The objectives of this research are to: characterize the type and sources of waste in the industry; assess the implication of waste management practices of ZIL; compare the existing waste management practice(s) of ZIL with international best practice towards identifying gaps and proposing alternatives. A total of 252 Industrial workers, farmers and settlers around ZIL were studied using key informant interview (KII) and random sampling techniques. Tables, percentages and charts were used for the analysis. The study established that majority of the respondents sampled were farmers and resident within 20km radius of ZIL and were youths of ages between 20-35 years old. The activity also involves young ones, so by implication are exposed to various diseases. A relatively high proportion (60.7%) of respondents were engaged in other occupation like Motorcycling (Achaba), Butchering, casual/industrial work etc. aside dry/rainy season farming amongst other agricultural activities. About 85% of the respondents do cultivate crops ranging from Onions, cabbage, carrot amongst other vegetables. They claimed that industrial effluents pollute and degrades farm lands. Majority of about 73% of the respondents disclosed that they knew about the disposal point where the industry discharges of its effluents. Not until of recent say 10-15 years when they found out that the effluent stopped flowing through the channel and is been replaced with a suck away dug within the company where the effluents are stored. Chemicals in the effluent when released into water bodies destroyed/affected both plants and aquatic lives, it also brought about water logging and bad land (soil infertility). Also, effluents from ZIL contain harmful substances such as harmful chemicals, particles of metal, among others. Threats may include: litter to the environment, diarrhoea, Cholera, Typhoid etc to human beings. Laboratory result revealed that the Biochemical Oxygen Demand (BOD) was found to be 10 mg/l, 12 mg/l and 7 mg/l for stream water, well water and soil respectively which is below World Health Organization (WHO) and National Environmental Standards and Regulations Enforcement Agency (NESREA) standard for a normal stream, well and soil quality. COD for stream water was 95 mg/l, 89 mg/l for well water while soil was found to be 92 mg/l within and around the said radius of the industry. Thus COD is higher than the BOD in all the mediums; these will actually pose serious challenge to living organisms. Key Informant Interview (KII) revealed that waste management practice in ZIL is not completely adequate simply because some of the effluents, solid waste, sludge etc directly or indirectly get to water bodies and soil. 83% of the respondents claimed that the company does generate waste like: solid, liquid effluents and sludge and also do not carry out re-use/recycling activities, waste disposal point is landfills. ZIL do not practice color coding in the process of segregation of waste and do not use UN (United Nations) approved containers etc. ZIL practice is actually contrary to international best practices on the basis of the KII conducted. However, challenges militating against proper management of waste of any kind in ZIL are categorized into: lack of a functional heavy duty machines; not imbibing the international best practice act among others.

It is concluded that adopting international best practices with the right support as far as an industry is concerned, is a sure way of attracting suitors from within and beyond ZIL. Incorporating that into the company will also alleviate the suffering of farmers and residents within and around the study area.

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CHAPTER ONE: INTRODUCTION

1.1 BACKGROUND TO THE STUDY

Industrialization is no doubt a factor of economic growth and development due to multiple benefits industries provide. Despite these benefits, industrial processes have externalities among which is the volume and variety of waste they generate. Some of these are solid, liquid or gaseous. Of all these, liquid waste called effluent can be isolated for investigation owing to its management peculiarities (Textile Exchange, 2012); similarly solid waste poses formidable challenge of management.

Zeeshan (2011) notes that ‘effluents’ are waste process water generated as a result of processes from a textile or any other mill. The character and composition of an effluent depends upon the mill and the process being carried out. Textile effluents are generally complex in composition and; in the untreated state, can be toxic to fish, animal and plant life; they therefore require to be adequately treated before they can be safely discharged into rivers and streams. Heavy metals such as chromium, copper, zinc and mercury can be found in many textile wastewaters, especially those of wool and synthetic finishing. These, along with other toxic chemicals, are detrimental to biological organisms and would harm the receiving stream. The specific limits of these in drinking water range from 0.001mg/l for mercury to 5mg/l for zinc (Sharmal and Garg, 2009).

Solid waste are also produced in most textile mills, mainly from rejected fabric, fibre, containers, and bags among others, most of which is being utilized by the secondary users. More so, some solid waste like rejected cloth, shoes etc. can be reused (Environmental Technology Program for Industry (ETPI) (1998).

Textile industry can be classified into three categories viz., cotton, woolen, and synthetic depending upon the raw materials used. The water consumption and wastewater generated from a textile industry depend upon the processing operations employed during the conversion of fiber to textile fabric. Textile industries are major sources of these effluents due to the nature of their operations, which require water that results in high wastewater generation (Ghoreishi and Haghighi, 2003).

Textile industries are distinguished by raw materials used which determine the volume of water required and hence the waste effluents generated. Production may be from raw cotton and synthetic materials. In this type of production, slashing, bleaching, mercerizing, and dyeing are the activities where waste effluents generation containing high biological oxygen demand, chemical oxygen demand, total dissolved solid, total suspended solid, oil and grease, pH, anions, temperature, colour and heavy metals are discharged with adverse effects on biological activity in water environment and man (Talbot, 1979). Specific water use in the textile industries varies from 60-400 l/kg of fabric, depending on the type of fabric (Pollution Research Group (PRG) 1998).

Textile wastewaters are usually high in temperature. Their temperature must therefore be sufficiently reduced before being discharged into the receiving stream, because the natural aquatic environment is a living system and could be seriously harmed by high temperature. Some textile processes require highly alkaline conditions, while in others; highly acidic conditions are needed. Thus, wastewater pH can vary greatly over a given period, and some form of neutralization or equalization is necessary prior to treatment. The treatment should produce an effluent with acceptable pH for discharge to the receiving stream. Grease and oil are harmful to biological systems and aesthetically damaging to the environment. These should be eliminated or strictly limited in concentration (Bhattacharjee, 2009).

Effluent wastes disposal has become an important factor in the running of factories in many industries all over the world. In the continuing campaign to reduce pollution of land and waters and deterioration of living standards and the general environment caused by increasing size of towns and increasing industrialization, laws have been enacted in many countries to penalize individuals or group of people, responsible for pollution. The laws are varied and are continually being amended (Vaidheeswaran, 2009).

The key environmental issues associated with textile industry are water use, treatment and disposal of aqueous effluent (Odjegba and Bamgbose, 2012). In many developed countries (Britain, Canada, US etc.), toxicity tests on industrial effluents are required to ensure that such discharges will not have adverse effects on the environment (Whitehouse and Dijk, 1996).

Nkeonye (2009) noted that in Nigeria, the Federal Environmental Protection Agency (FEPA), established by Decree No. 58 of 1988, is vested with the responsibility of environmental protection, initiation of appropriate environmental policies and international cooperation on environmental matters. The FEPA (Amendment) Decree No. 59 of 1995 further expanded the mandate of FEPA to include the protection and conservation of Nigeria's biodiversity and natural resources. So, it has the power to ensure minimal pollution of the country’s land and water resources from effluent discharge.

The active (polluting) materials in a textile effluent originate from two sources: (a) the textile material being processed, and (b) the chemicals used in the various textile processes. The pollutant may be present naturally in the fibre (e.g. grease), or added by the textile manufacturer to facilitate processing e.g. size (starch), lubricant. The processes of textile manufacture lead to the transfer of fibre impurities and unfixed chemicals (including colour) into the process water, and hence to pollution of the effluent (Chukwudi, 2008). In addition, textile processing industry does not produce hazardous solid waste. Quantity of waste depends on technology and in-house practices. Rejected fabric is the primary contributor to the solid waste. Normal rejection rate is between 3% to 7%, which largely depends on in-house practices. Most of the solid waste is reused for different purposes. Solid waste, such as rejected cloth and empty chemical containers etc., is generally sold to the secondary users. A small proportion of it is also used internally (ETPI, 1998).

The management of waste is a formidable problem. However, the overall guiding principle to protect the environment is to 'reduce, re-use, repair or recycle', and actual disposal of wastes should be the last resort (Chukwudi, 2008). In general, Integrated Waste Management System (IWMS) provide options of handling waste. Source reduction, re-use and recycling are options that are very vital in a study of this nature (Sharmal and Garg, 2009). This essentially stems from the cost effectiveness and environmental safety associated with IWMS. Zaria Industries Nigeria Limited produce textile related materials such as tarpaulin but how the effluent and other waste are managed within best practice options to ensure environmental safety is not clearly understood. This is the focus of this research.

1.2 STATEMENT OF THE RESEARCH PROBLEM

ZIL was incorporated as a limited liability company in 1975 under the leadership of the then north central state Government with Japanese as partners. Kaduna state government still holds a substantial shareholding. The company is the only manufacturer of tarpaulin material used in the construction of tents, camp beds, truck covers, large or medium tarpaulin for covering foodstuffs or any perishable or non perishable items. As a result of their years of experience of satisfactory supply of tarpaulin products to meet customers' requirement, specific designs of finished tents that are marketable and ready to use, are put at the disposal of their clientele over Africa (ZIL, 2013).

The type of yarn used in the manufacture of tarpaulin fabrics is also used in the production of tents and related products. Consequently their products are produced from high quality 100% cotton yarn, as opposed to tarpaulin made from nylon or PVC. Since cotton materials are generally weather friendly, it has excellent durability, and water repellency; moth proof and highly resistant to mildew attacks. Its guaranteed flawless refinement of tarpaulin tents manufacture is in compliance with the relevant national and international quality assurance regulations/standards (ZIL, 2013).

Textile manufacturing by its very nature has major ecological and social impacts. The process of making textiles can require several dozen gallons of water for each pound of clothing, especially during the dyeing process. The water intensive textile processing industry needs to employ the process of recycle and reuse of wastewater so as to cut-down on volume of effluent discharged into the environment. With Nigeria's water resources depleting, both stemming out of its own concern for the shrinking ground water, wastage is always on the increase without recovery in order to complement the resource that is tending towards becoming a finite resource. This does not comply with regulatory requirements (best practices) whichbased on conventional technology or advanced technology is the answers for the textile processing sector (Zeeshan, 2011).

Textiles could be one of the most un-sustainable products in their entire lifecycle. From growing the raw material or creating it from oil to manufacturing and selling and final disposal; they can create serious problem. For wet processing of textiles, textile industries consume large volumes of water and chemicals; the chemical reagents used are very diverse in chemical composition, ranging from chemical compounds to polymers and organic products. As environmental regulation became stringent, new and novel processes for efficient treatment of various kind of waste at relatively low operating cost are needed (Sara, 2009).

These effluent treatments comprise membrane treatment system. Textile multiple filtration system is a recycling plant that can recycle effluent waste (waste water) for reuse by the textile industries. All effluent waste generated in textile industries can be recycled through a sequence of anaerobic digestion and aerobic treatment followed by granular or activated carbon (GAC) or membrane treatment (Visvanathan and Asano, 2010).

Furthermore, treatment cost of textile waste effluents has been escalating fairly rapidly in recent years. The textile industry creates a host of pollution problems, dyes and chemicals are discharged as effluents into waterways by factories, and they release heat, fly ash and sulfurous and nitrous compounds into the air, thus contributing to acid rain. Toxic chemicals, textile packaging and drums are dumped into landfills.

Also, the used fabrics themselves are a problem; the subsequent fabric makes a toxin that swells into the ecosystem in the production process like bleaching and then dyeing. During the production process controlling pollution is as vital as making a product free from the toxic effect. The utilization of rayon for clothing has added to the fast depleting forests and opened the door to the development of natural sustainable fibers like organic Cotton, Hemp and Bamboo fibres. Petroleum-based products are equally harmful to the environment (Sharmal and Garg, 2011).

A number of studies have been done on textile manufacturing industries and their waste management challenges. Some of these are examined to set the position of this work.

In Nichemtex Company in Ikorodu, Lagos state; the treated effluents are being discharged through drainage channels into the Ibeshe stream which subsequently affects the water quality of the stream. Depending on the dosage and exposure period, the effluents could be poisonous to plants, aquatic life and humans. Most of the industries in Lagos state do not control their wastewater effluents by processing, waste recycling or end-of-pipe treatment. Thus, effluents with some levels of toxic substances are being discharged into the environment (Odjegba and Bamgbose, 2012).

Programmes for planned industrial recycling and reuse began in the USA in the 1940s when chlorinated domestic wastewater effluent was used for steel processing. In Sweden, a 5 to 6 fold increase in reuse was recorded from 1930-1970. During the last quarter of the century, the benefits of promoting wastewater reuse as a means of supplementing water resources have been recognized by most state legislatures in the United States and the European Union. Interest in reuse is now growing in other parts of the world in response to demand for high quality, dependable water supplies for agriculture, industry, and domestic uses but it has only been in the last quarter of this century that wastewater reuse technologies have been adopted in Asia. For example, practices implemented in China have resulted in an average rate of industrial effluent waste reuse of 56 percent in 82 major cities in 1989, with a maximum reuse percentage of 93 percent (Visvanathan and Asano, 2010).

Sara (2009) worked on cutting water usage in textile industry and showed that textile mills are amongst the largest generators of effluents, due to the very large quantities of water required in the various textile wet processes. For example, a wool textile industry requires about 100 million gallons of water each day for scouring, washing-off after milling and dyeing. The basic factors that bear on effluent quantity and quality are (i) type of fibre; (ii) the number of unit operations constituting the overall textile finishing process; (iii) process chemicals; and (iv) recycling and conservation procedures in force.

According to Rathore (2011), about 800 textile industries are working on the banks of river Bandi, Pali hub of Rajasthan state. These textile industries discharge effluent into the river Bandi, a non perennial river thus severely contaminating both the river as well as the groundwater. At present their effluent treatment plants commissioned to combat pollution are not having required capacity to treat the large quantities of effluents generated by textile units including city sewage. The untreated industrial effluent flows regularly in the dry bed of river about 45 km downstream Pali.

Paul, Chavan, and Khambe, (2012) studied characterization of textile industrial waste water in Solapur focusing on characterization of waste water with the help of important pollution indicator parameters like potential hydrogen (PH), biological oxygen demand (BOD), chemical oxygen demand (COD), and total dissolved solid (TDS), sulphide, sulphate, hardness, alkalinity, calcium and magnesium. They also assess the pollution potential due to effluent discharged by textile industries in Solapur city. They found out that all the six textile industrial effluents contain BOD value between 170 to 450 mg/L and average value is found to be 348 mg/L, this value is higher than prescribed standards stipulated by Central Pollution Control Board (CPCB). The value of COD of given textile effluent ranging from 455 to 1349 mg/L and average value is 817 mg/L, which is also higher than CPCB standards. The higher value of COD is due to especially from dying section of textile processing industry because of nature of chemicals employed.

Subki and Rohasliney (2011) researched on Batik effluent in Kelantan state, Malaysia. The study focused on the physical characteristic of the batik effluents. They revealed that the value of chemical oxygen demand COD is between 700 to 4900 mg/L which is higher than the acceptable condition for discharge of industrial effluent containing COD for textile industry. Correlation analysis showed that COD was positively correlated with temperature and pH, and was negatively correlated with DO and TDS. With the increase demand of batik products, the effluent with high COD value will also increase and making it one of the main sources of severe pollution in Malaysia.

The BOD and COD ratio is less than 0.5.Their study indicates that the effluent contains a large proportion of non-biodegradable matter (Ikhu-Omoregbe, Pardon, Muzenda, and Mohamed, 2009).

ETPI (1998) in a study on textile sector in Pakistan focuses on environmental problems caused by textile processing industries. It was revealed that textile processing unit produces general types of solid waste and the quantity of waste depends on the technology and in-house practices. A typical list of solid waste generated from textile processing units is presented in Table 1, along with possible sources and disposal practices.

Table 1.0: Textile Solid waste generation

S/N	Type	Source	Use
1	Rejected Fabric	· Rotary · Stenter · Garment stitching	Sold to low income people for clothes
2	Waste Fabric	· Stenter (Bleached dry-form) · Stenter (Finished width) · Garments stitching	Sold to low income people and used as ragged for cleaning purpose.
3	Fibre	Rotary machine	Sold to low income people and used as filler material.
4	General i. Wooden pieces ii. Iron pieces iii. Card board iv. Carton	Process and Office Area	i. Sold and used internally in textile unit, and sometimes used for burning purpose; ii. Sold to low income people and used in local iron blast; iii. and iv. Used internally and sometimes used by small shopkeepers.
5	Containers · Metal Container · Plastic Container		Sold / used internally by local chemical manufacturer, as well as by low income people for household purposes.

Source: Adapted from ETPI (1998).

They further note that rejected fabric is generated at two levels i.e. at the raw material inspection stage and after the processing of the fabric. Also, all items listed have certain resale value and have potential for downstream reuse.

Adebayo, Otunola, and Ajao, (2010) assessed the level of environmental pollution due to effluent from textile industries before and after the effluent has been treated biologically. The sample of effluent was treated with mixed culture of *Aspergillusspp* and the treated sample was analyzed for the level of BOD, chemical oxygen demand COD, SS, DS, TS, colour and odour. The samples of effluent were obtained from international textile industries Nig. Ltd, Odongunyan industrial estate Ikorodu Lagos state, Nigeria. The study emphasizes the significance of minimizing the pollutants load in the effluent to be treated at the end of the production. The results revealed initial level of pollutant in the effluent. It shows a high degree of COD, BOD, TS, SS, DS, odour, colour intensity and acidity. Their findings further revealed that the overall efficiencies of COD, BOD, TS, SS, and removal of the biological treatment are found to be 75, 97.3, 99.5 and 96.6%, respectively.

Challawa River in Kano has also been investigated for the impact of effluent from tanneries and textile industries on it chemical characteristics by Akan, Abdulrahman, Ayodele, and Ogugbuaja, (2009): The samples collected at some selected points along the river was investigated for parameters such as BOD, COD, TOC, DO,TDS, anions and trace elements. The result indicate that all the investigated parameters were found to be higher than the limits set by WHO for the discharged of tanneries and textile effluents into rivers and also for the protection of fish and other aquatic life.

Yusuf and Sonibare (2004) investigated effluents from five major textile industries in Kaduna. These effluent were tested for colour intensity, COD, TSS, NH_3, BOD, and S_2- also metals such as Al, Mn, Zn ,Fe, Cu were also investigated. Al, Mn, Zn, Fe were found to be within limit while Cu was found to be above limit about three fold.

Asia, Ndubuisi, and Odia (2009) also studied the physicochemical properties of some selected heavy metals in three effluent samples collected from textile factories in Kaduna. Their findings shows that the heavy metals investigated has higher concentration than the Federal environmental protection agency (FEPA) standards for effluent discharge, physicochemical properties result indicates that the effluents may not be able to undergo up to 50% substrate biodegradation, thus biological processes may not be feasible for the treatment of these effluents. Wastewater samples at the point of discharge into river Chalawa were collected and analyzed for metals such as Cr, Cu, Pb, Zn, Fe and Mn, the investigation was done for both wet and dry season and their result shows that the discharge of Cr, Cu, Pb, and Zn into the river, for both seasons, exceeded the maximum permissible limit given by FEPA and WHO (Egila, Dauda, Iyaka, and Jimoh, 2011).

Olusegun, Fidelia, Peter, and Odeigah (2010) compared cytogenotoxicity effects of ‘treated’ industrial effluents discharge from textile and paint industries in Lagos metropolis using A.cepa root-tip assay. They reported that textile effluent was found to be 4.5 times more toxic than the paint effluent.

Awomeso, Taiwo, Gbadebo, and Adenowo (2010) studied a river receiving effluents from textile industry in Lagos, dissolved oxygen at the points closest to the point of effluent discharge were found to be zero signifying that stream was heavily polluted and may not likely support aquatic lives. They also assert that effluents generated from the textile industry located in Oshodi, Lagos state has also been investigated for its characteristics and to test the effectiveness of their waste water treatment techniques. Physico-chemical parameter investigated include pH, temperature, total solid, total suspended solids, dissolved oxygen, chemical oxygen demand, oil and grease, chlorides, sulphide and certain heavy metals such as chromium, cadmium and lead. The range of the physioco-chemical parameter was reported as follows pH 7.12-12.99, temperature 28.33-64.00°C, TS 2000-31800 mgL-1, TSS 300 – 780 mgL-1, DO N.D - 1.50 mgL-1, COD N.D – 350 mgL-1, oil and grease 160 – 2370 mgL-1, Chlorides 21 - 1064 mgL-1, Sulphide 1060 – 1400 mgL-1, Chromium (Cr) 0.09 - 0.67 mgL-1, Cadmium (Cd) 0.04 - 0.31 mgL-1 and lead (Pd) N.D - 0.35 mgL-1**.** The percentage removal was also reported in the following range: TS; 15.1 - 86.5%, TSS; 46.4 - 51.3%, oil and grease; 35.0 - 92.9%, chloride; 27.6 - 65.5%, sulphide; 18.5 - 24.3%, heavy metals (Cr, Cd and Pd); 2.9 - 86.6%, temperature; 27.9 - 55.7%, pH; 20.3 - 45.2%. Based on the results of their investigations, it was concluded that the wastewater treatment technique as practiced by the company is inadequate to remove all the pollution loads generated (Ogunlaja and Ogunlaja, 2009).

There is a general consensus that proper management of effluent waste could have multiple socioeconomic and environmental benefits. However, none of the studies accessible (e.g. Sara, 2009; Rathore, 2011; Paul *et. al.*, 2012; Subki and Rohasliney, 2011; Ikhu-Omoregbe *et. al.*, 2009; ETPI, 1998; Adebayo, *et. al*., 2010; Akan, *et. al*., 2009; Yusuf and Sonibare, 2004; Asia *et. al.*, 2009; Egila, *et. al*., 2011; Olusegun *et. al.*, 2010; Awomeso *et. al.*, 2010; Ogunlaja and Ogunlaja, 2009), investigated how effluent could be effectively managed. Rather they focus on pollution of water bodies by effluent from textile industries. More so, none of the accessible work paid attention to the systematic study of waste management practices in Zaria Industries Nigeria, Limited (ZIL) this is because the waste generated by ZIL has more impact on the local environment and the immediate surroundings of Zaria which because of rising population can result in disaster of some magnitudes. The dearth of such work is an important research gap needed to be urgently filled. The research questions posed are as follows.

i. What are the type and sources of waste generated by ZIL?

ii. What are the socioeconomic and environmental implications of the existing waste management practice of the company?

iii. Are the waste management practices in line with international best practice or better alternatives should be adopted?

1.3 AIM AND OBJECTIVES

The aim of the study is to assess the existing waste management practices of Zaria Industries Nigeria, Limited, Zaria, Kaduna State, Nigeria. The specific objectives are to:

i. characterize the type and sources of waste in the industry.

ii. assess the implication of waste management practices of ZIL.

iii. compare the existing waste management practice(s) of ZIL with international best practice towards identifying gaps and proposing alternatives

1.4 SCOPE AND DELIMITATION OF THE STUDY

The purpose of this study is to assess the effectiveness of waste management practices of Zaria Industries Nigeria, Limited, Dakache. This industry was chosen because of the availability of "*finishing Unit*" in the textile mill.

The study, therefore, examine type and sources of waste generated, existing waste management practices. However, the focus was limited to waste generated at different stages of finishing and spatial discharge areas. In addition, for each of the practices identified, a comparative analysis of its effectiveness in relation to international best practices was undertaken. The extent to which the practices (in terms of production/waste management) are in line with best practices in ZIL from inception to date (1975-2014) was assessed.

1.5 JUSTIFICATION FOR THE STUDY

Zaria Industries Nigeria Limited (ZIL) located in Zaria, Zaria Local Government Area, Kaduna State is one of the largest tarpaulin production companies in West Africa (Chukwudi, 2008). It churns out tarpaulin in millions of tonnes which is consumed nationwide and within the African sub-region. ZIL is located in Dakache, with adjacent farmlands and few settlements in proximity (see figure 3.1 and 3.2). The quality of tarpaulin produced is very high indicating that effluents and other waste of different volume and chemical compositions are generated during production process. However, little is known about its waste management practices in spite of the assertion of Chukwudi (2008), that waste management practice is required to keep the environment safe from contamination.

Most textile industries globally are faced with waste treatment challenges; this is more paramount in developing countries like Nigeria. The population of Zaria where ZIL is located and the neighboring countries benefiting from it is expanding at a geometric rate thus making the demand for tarpaulin materials to be fast increasing, hence, greater production in order to meet the demand. Industrial discharges especially effluents into water bodies pose adverse effect on the environment and inhabitants around the area where such industries are situated or where the company empties its waste.

This situation necessitated the use of waste management best practices (i.e. reduction, reuse, recycling etc.) enacted and practiced by most developed countries of the world, since as earlier stated little is known about ZIL management practices to contribute significantly in the environmental and socio-economic development of the people in the study area and beyond.

In terms of contribution to knowledge on industrial waste and urban environmental management, findings of the study formed a base knowledge for researchers interested in that area. It is the author’s hope that this thesis will contribute to finding a sustainable way of managing industrial waste menace in Zaria Industries Limited with adaptive implications for the whole country and beyond.

CHAPTER TWO: CONCEPTUAL FRAMEWORK AND LITERATURE REVIEW

2.1 CONCEPTUAL ISSUES

2.1.1 Waste

The term 'waste' has different meaning for different people. In general, waste is 'unwanted' for the person who discards it; a product or material that does not have value anymore for the first user and is therefore thrown away. But 'unwanted' is subjective and the waste could have value for another person in a different circumstance, or even in a different culture (Van de Klundert and Justine, 2001). The United Nation Statisctics Division (2011) see wastes as materials that are prime product for which generator has no further use in term of his/her own purposes of production, transformation or consumption, and of which heshe wants to dispose. Furthermore, solid wastes arise from unusable residues in raw materials, leftovers, rejects and scrap from process operations, used or scrap packaging materials and even the saleable products themselves when they are finally discarded. Equally, Waste is defined as any substance or object which the holder discards or intends to discard (Abdullahi, 2011).

From the aforementioned definitions, one by Van de Klundert and Justine (2001) is thus adapted for this study.

2.1.2 Waste Management Practice

2.1.3 Textile Processing Industry

Due to limited literatures and similarities in terms of textile processing including tarpaulin production in most of the industries globally; processing units in Karachi (Pakistan) will be used as an example and thus will form part of the conceptual frame work for this study. The number of industries working in this sector is estimated to be around 670. Karachi (Pakistan) has the major share with almost 300 units. Apart from Karachi, most of the textile mills are located in Lahore and Faisalabad (Vital Information Services, 2010).

All textile processing units apply various textile processes, ranging from desizing and bleaching to calendaring. However, many of these units apply only some of the processes, such as only bleaching or dyeing. The total capacity of all these units in Pakistan is reported to be about 4,400 million m^2.

According to Vital Information Services (2010), the Pakistani textile processing mills produced a total of 15,482 sq. m of bleached fabric, and 69,565 sq. m of dyed and printed fabric. This accounted for 4.92% and 22.09%, respectively, of the total fabric produced in Pakistan. Apart from this, some 59,835 sq. m of blended fabric, which accounted for 19% of the total, was also produced. The total number of reporting mills was 429 that year, which rose to 435 in the subsequent year.

2.1.4 Raw materials

Generally, the major raw materials used in textile processing consist of the following:

(1) Cotton

(2) Polycotton (a blend of 65% cotton with 35% polyester)

(3) Panama (100% cotton consisting of a heavier and thicker yarn)

(4) Satin (a blend of cotton and polyester, generally in a 50:50 ratio)

(5) Polyester (based on 100% synthetic yarn)

2.1.5 Process description

100% polyester product is of relatively limited importance, and is generally processed for the local market.

Various processes of different nature are carried out to convert raw (grey) fabric into a finished textile product. These processes and operations can be divided in three broad categories:

(i) Pre-treatment

(ii) Colouring (Dyeing / Printing)

(iii) Finishing

It is important to note that fabric is not necessarily passed through all three categories; it follows the process chain in accordance with the characteristics required in the final product.

2.1.6 Pre-treatment processes

Pre-treatment processes are aimed at preparing the fabric for the subsequent coloring process. However, at times pretreatment is all that is required. Pre-treatment processes include singeing, desizing, scouring, bleaching, mercerizing etc. A number of washing steps are also included in the pre-treatment.

(a) **Singeing**

Singeing operation involves direct exposure of the fabric to a flame for a specified time. It destroys tufts and hair *etc*. from the surface of fabric by controlled burning, thus improving chemical uptake quality of the fabric. This prevents uneven impregnation, and also ensures reduction of fluff emission to wastewater, in subsequent processes.

(b) **Desizing**

Desizing is done to remove "size" from the sized fabric. "Size" is an adhesive substance applied to facilitate weaving. This is removed with the help of enzymatic desizers, wetting agents, and soap. The process is followed by washing.

© **Scouring**

Scouring process removes oil and grease spots, dirt, etc. from the fabric. It is almost identical to the bleaching process except for some difference in the chemicals used, and can be performed separately or in combination with bleaching. Neutralization is done after scouring, followed by washing.

(d) **Bleaching**

The primary objective of bleaching is to remove coloring impurities, dirt, and undesired impurities from the fabric. This can be done in two ways; continuous, or batch wise.

For continuous bleaching process open width or bibcock bleaching machine is used. Batch bleaching process is performed in jet or winch machines. However, it should be noted that the latter case exist with low frequency. Keir bleaching machine is also used for bleaching by batch process.

(e) **Mercerizing**

Mercerizing is a post bleaching, pre-coloring process, generally applied for high quality product. Mercerizing is generally applied to the fabrics which are subsequently to be printed. It can also be applied to the fabric to be dyed, but the practice is very rare.

It enhances the capability of the fabric to retain dyes through a uniform swelling of cotton fabric. It also improves the wash fastness of the fabric and gives luster to its surface and increases the tensile strength and susceptibility to dyes.

As earlier discussed, pre-treatment processes are aimed at preparing the fabric for the subsequent colouring process; it is further represented in flow form (see fig. 2.1):

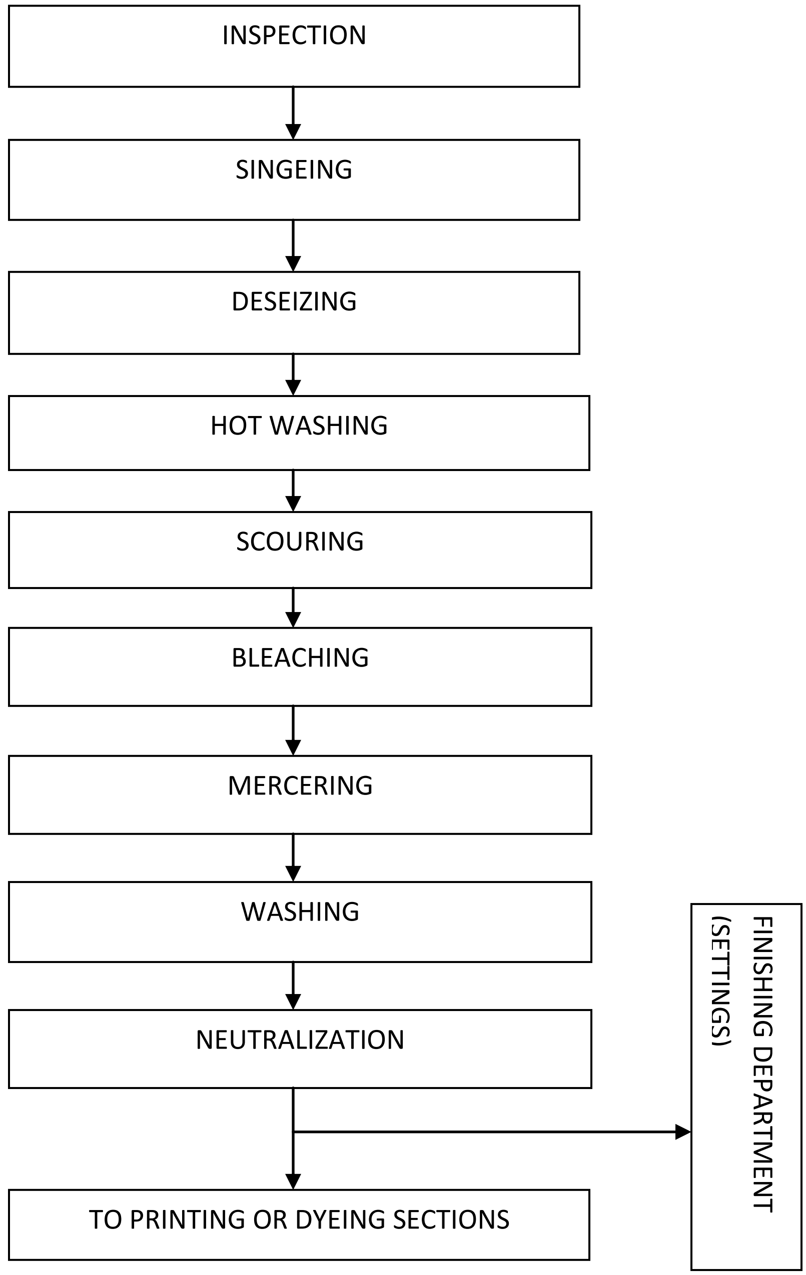

Fig. 2.1: Flow diagram of pre-treatment Process

Source: Vital Information Services (2010).

It is important to note that the above processes discussed actually lead to waste generation of any form i.e. effluents, solid waste, gaseous waste etc in any textile processing industry globally. The management of such waste is what differs from developed to developing countries.

2.2 LITERATURE REVIEW

2.2.1 Environmental problems of the textile processing sector

Environmental problems of the textile industry are mainly caused by discharges of wastewater, but emissions to air, noise pollution and solid waste generation are also important. The use of chemicals has considerable influence on the industry's environmental impacts. During the past few decades, awareness of environmental problems has increased considerably, and during recent years environment has become an important issue in the textile trade. This development has been accentuated by pressures from government authorities, requirements set by importers and customers in the form of ISO 9000/140000 certification as well as from foreign institutions engaged in the financing of new projects. The textile industry is characterized by a large quantity of water consumption, and the variety of chemicals used. Generally, there are a number of wet processes involved with high requirements for resource inputs, generating several types of wastewater. Other important features of this industry at unit level are high fluctuations in flow rates and waste concentration due to the factors of production size and process cycles (Environmental Technology Programme for Industry (ETPI) 1998).

Liquid waste tends to dominate over air emissions and solid wastes in terms of severity of environmental impacts. Liquid waste arising from various steps of operations contains substantial pollution load in terms of organic matter and suspended matter, such as fibers and grease. Chemicals may also adhere to these suspended particles. Wastewater is generally hot and alkaline, with a strong smell and color due to the utilization of a variety of dyes and other chemicals in the dyeing processes.

Solid waste is also produced, mainly from fabric rejects, fiber, containers, and bags etc., most of which is being utilized by the secondary users. No significant amount of hazardous waste is generated. Energy wastage is also an issue, stemming mainly from discharge of water and air without heat exchange in majority of the cases. Condensate recovery and reuse system is non-existent in some, and unsatisfactory in most of the cases, which is also a cause of energy wastage (ETPI, 1998).

Certain chemicals which are used in the textile industry cause environmental or health problems. These problems may occur during the production process, with respect to emissions or occupational health problems. Certain chemicals, for example bleaching agents and detergents, are almost completely washed out in the wastewater, while others, such as dyestuff, are retained by the product. Other problems caused by chemicals used appear because of their presence in the final product, for instance allergic skin reactions or even cases of cancer. Many of the dyes used have a slow degradation process and may contain metals, especially copper and zinc. Small emissions of cadmium, chromium, and lead may also occur. Some of the dyes used are very toxic. One of the major issues in the textile section is the international regulations against Azo dyes (ETPI, 1998).

2.2.2 Effluents Acts/Laws

In Britain, an effluent, from whatever source, must not enter a water course without prior consent of the River purification Boards and consent is usually based primarily on the Royal Commission Standards of less than 20mg/l 5-day Biochemical Oxygen Demand (BOD), and less than 30mg/l Suspended Solids (SS). In addition, legislation governs the total concentration of substances in solution (Bhattacharjee, 2009).

Until recently, discharge to rivers, or liquid discharge to land which might contaminate underground water courses, was governed in England and Wales largely by the Rivers (Prevention of Pollution) Acts of 1951 and 1961, and the Water Resources Act of 1963. The Control of Pollution Act of 1974 (U.K.) is the latest piece of environmental legislation concerned with the disposal of solid wastes, atmospheric pollution and noise, in addition to the pollution of water.

The Act makes it an offence to cause or knowingly permit any poisonous, noxious or polluting matter to enter any relevant waters; or any matter to enter a stream so as to tend to impede the proper flow of the stream in a manner leading to or likely to lead to substantial aggravation of pollution; any solid waste to enter a stream or restricted waters. The Act gives to the water authorities the power to exercise stricter and wider control of effluents, the ability to stop discharges and the power to charge for disposal into rivers or streams. Acts of this type contain an extensive list of prohibited or restricted materials and the tolerable limits for discharge, failing which a stiff penalty will be imposed (Sharmal and Garg, 2009).

According to Taesler (1991), in Canada, the Fisheries Act is relevant to all parts of the country since the Act covers control of pollution in all waters frequented by fish. While in the United States, water pollution regulatory constraints are imposed on the manufacturer of textile fabrics mainly by Section 304(b) and 306 of the Federal Water Pollution Control Act, as amended (1972). The Act provides for the United States Environmental Protection Agency (EPA) to issue effluent limitation guidelines applicable to the point-source discharge of industrial wastewater. The guidelines for textile mills is based on the EPA Development Document, a technical study that characterizes the industry, describes the sources of water pollution, and presents suggested permissible effluent levels based upon recommended technology and its associated cost.

ETPI (1998) disclosed that with the promulgation of the Pakistan Environmental Protection Act-1997, the Pakistani textile industry will be forced to comply with the regulations for environmental protection. The Pakistan Environmental Protection Council’s Environmental Standard Committee has proposed Environmental Improvement Charges to be imposed on the industries not complying with NEQS. A formula for calculations of these charges has already been devised. Therefore, every textile processing mill would have to thoroughly investigate its existing operations with the aim to identify opportunities for minimizing the environmental impacts by implementing appropriate in-plant measures.

Nkeonye (2009) noted that; in Nigeria, the Federal Environmental Protection Agency (FEPA), established by Decree No. 58 of 1988, is vested with the responsibility for general environmental protection, initiation of appropriate environmental policies and international cooperation on environmental matters. The FEPA (Amendment) Decree No. 59 of 1995 further expanded the mandate of FEPA to include the protection and conservation of Nigeria's biodiversity and natural resources. So, it has the power to ensure minimal pollution of the country’s land and water resources from effluent discharge.

Recently, the National Environmental Standards and Regulations Enforcement Agency (NESREA) Act was introduced in Nigeria and Part II of the Agency’s Act dwells with the functions and powers of the Agency and Council. The Agency is authorized to enforce compliance with laws, guidelines, policies and standards of environment matters (section 7a), such standards would include the federal water quality standards and air quality standards. In executing its mandate, it is to co-ordinate and liaises with stakeholders within and outside Nigeria, on matters of environmental standards, regulations and enforcement (section 7b and d). Relevant stakeholders would include the organized private sector, environmental groups at both national and international levels and other ministries and parastatals (Egwu, 2011).

A remarkable provision of the NESREA Act is Section 7(c) which mandates the Agency to enforce compliance with the provisions of international agreements, protocols, conventions and treaties on the environment and such other agreements as may, from time to time, come into force. The Agency is also mandated to enforce compliance with policies, standards, legislation and guidelines on water quality, environmental health and sanitation including pollution abatement. It can therefore be implied that the functions of NESREA are directed primarily at the prevention of pollution and environmental harm rather than remedying harm that has already occurred to the environment.

NESREA is also concerned with the enforcement of guidelines and legislations on sustainable management of the ecosystem, biodiversity conservation and the development of Nigeria's natural resources. The Agency is empowered to establish mobile courts to expeditiously dispose of cases of environmental infringements, but this has to be done with the 'relevant judicial authorities' as well as in consonance with the Nigerian Constitution (Egwu, 2011).

2.2.3 Waste Material

The active (polluting) materials in a textile effluent originate from two sources: (a) the textile material being processed, and (b) the chemicals used in the various textile processes. The pollutant may be present naturally in the fibre (e.g. grease), or added by the textile manufacturer to facilitate processing e.g. size, lubricant. The processes of textile manufacture lead to the transfer of fibre impurities and unfixed chemicals (including colour) into the process water, and hence to pollution of the effluent (Chukwudi, 2008).

The management of waste is a formidable problem. However, the overall guiding principle, agreed by everyone, to protect the environment is to 'reduce, re-use, repair or recycle', and actual disposal of wastes should be the last resort (Chukwudi, 2008).

In general, Integrated Waste Management System (IWMS) provide options of handling waste. Source reduction, re-use and recycling are options that are very vital in a study of this nature (Sharmal and Garg, 2009).

Source reduction indicates little or even zero waste. Source reduction is generally the first step that should be considered in an integrated waste management system. Example is avoiding waste generation, internal reuse of waste, reuse in other products.

Recycling; Recycling is a key concept of modern waste management. Recycling is the re-processing of waste materials into new or reusable products. Ninety-nine percent of used textiles are recyclable. In many applications, especially where metals, glass or polymers (including synthetic textile materials) are involved, the recycling process can only slow down damage to the planet. The least expensive and least adverse effect on the environment is when a component can be recycled in to its original product, i.e. '*closed loop*' recycling. For example, face car seat fabric can be recycled into backing material (Sharmal and Garg, 2009).

Reuse; Reuse of effluent waste is an attractive economic alternative and helps conserve an essential commodity for future generations. Economic use also reduces the quantity of waste diverted to treatment facilities and further lowers treatment costs. Companies invest in wastewater treatment and reuse not just to comply with effluent standards but because product recycling and raw material recovery benefit a company’s image among other benefits. Furthermore, Industrial effluent waste treatment has taken place in a series of development phases starting from direct discharge to recycling and reuse. This development has been slow considering the growing awareness of environmental degradation, public pressure, implementation of increasingly stringent standards, and industrial interest in waste recycling and re-use. The declining supply and higher cost of raw water is also forcing industry to implement recycling technologies. Many industries are now concentrating on methods to abate potable water intake and reduce discharge of polluted effluent. The move toward wastewater reuse is reflected in different Cleaner Production approaches such as internal wastewater recycling, reuse of treated industrial or municipal waste effluents, and reuse of treated wastewater for other activities.

In addition, the potential for industrial effluent waste re-use is dependent on a variety of factors and differs from one industry to another. Industries consuming a large volume of water obviously have greater potential for internal reuse. Similarly, simple physical and chemical treatments may be sufficient for wastewater produced from activities such as washing floors and cooling. Other industrial wastewaters have high concentrations of toxic chemicals, which must be removed, but this is actually an advantage if useable by-products can be recovered (Visvanathan and Asano, 2010).

CHAPTER THREE: THE STUDY AREA AND METHODOLOGY

3.1 THE STUDY AREA

3.1.1 Location

The industry is located in Zaria under Zaria Local Government Area, Kaduna state, which lies between latitudes 11°03'N-11°05'N and longitudes 7° 43'E-7° 45'E, (See Figures 3.1 and 3.2). Zaria Industries Limited is located in the eastern part of Zaria, within the undulating high plains of northern Nigeria. Zaria is the administrative head quarters of Zazzau Kingdom (Musa, 1993). The area lies on about 762 metres above sea level (Ogunleye, 2006).

3.1.2 Weather and Climate

In terms of climate, Zaria lies within a region which has a tropical savannah climate, the tropical wet and dry (AW climate of Koppen's classification) with distinct wet and dry seasons (Hore, 1970). Precisely, it experiences five months of rainy season and seven months of dry season annually. The rainy season starts around May and lasts till September while dry season starts in October and ends in April. The region has a single maximum rainfall regime which comes during the month of August with a mean annual rainfall of about 1100mm. The rains are usually torrential lasting for a few minutes or few hours and are characteristically relatively of large drop sizes. The average yearly rainy days is put at about 92 days (Hore, 1970).

The daily maximum temperature rises gradually from 33°C in which month attaining its major peak in April; with some days have temperatures as high as 40°C. The temperature drops rapidly to its lowest level in August with some days as low as 26°C. Zaria is located such that it is invaded by two distinct air masses; one from the north which is dry and continental in origin known as the Tropical Continental Air Mass (CTS).

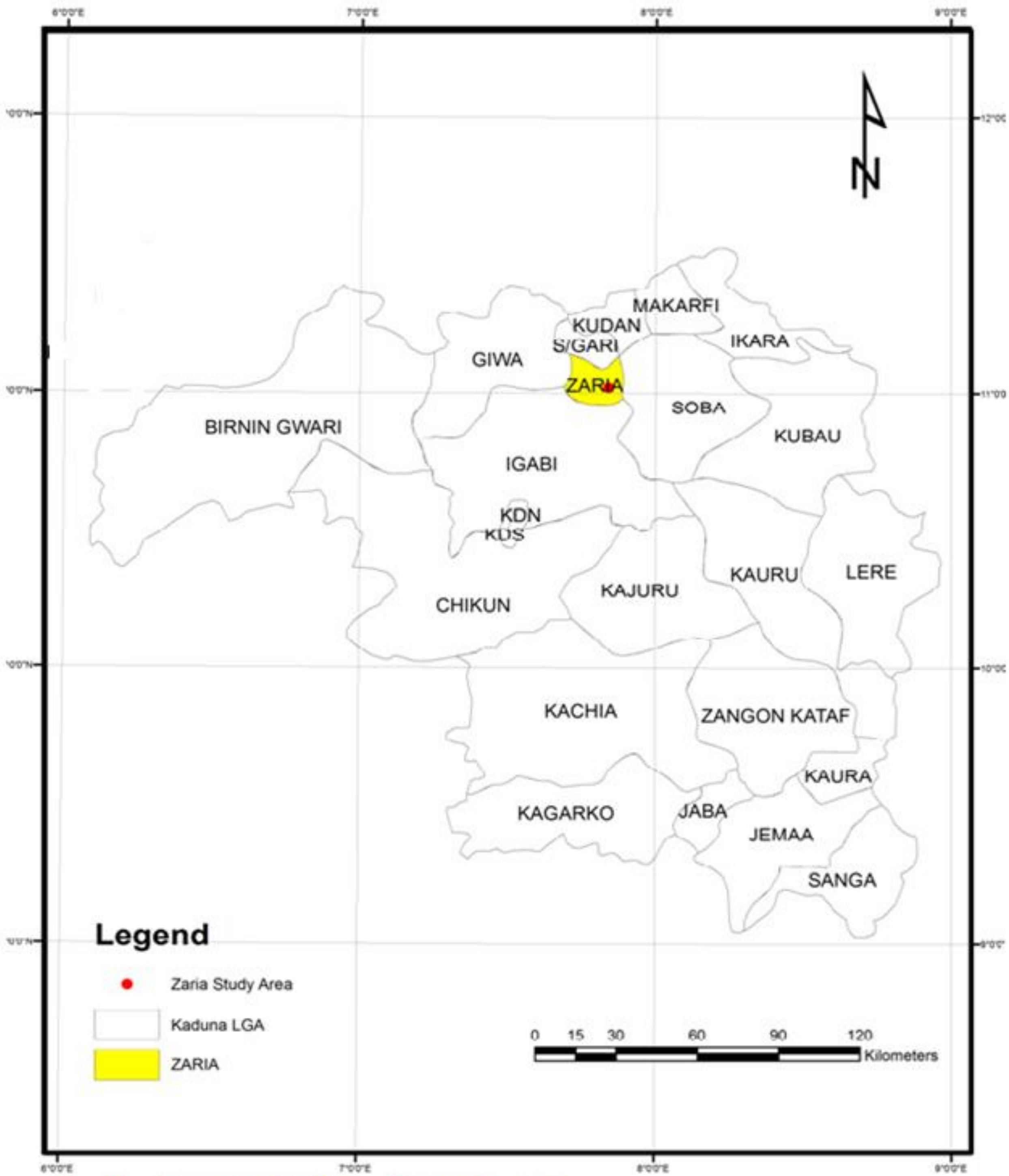

FIG.3.1: KADUNA STATE SHOWING THE STUDY AREA
Source: Modified from Administrative Map of Kaduna State

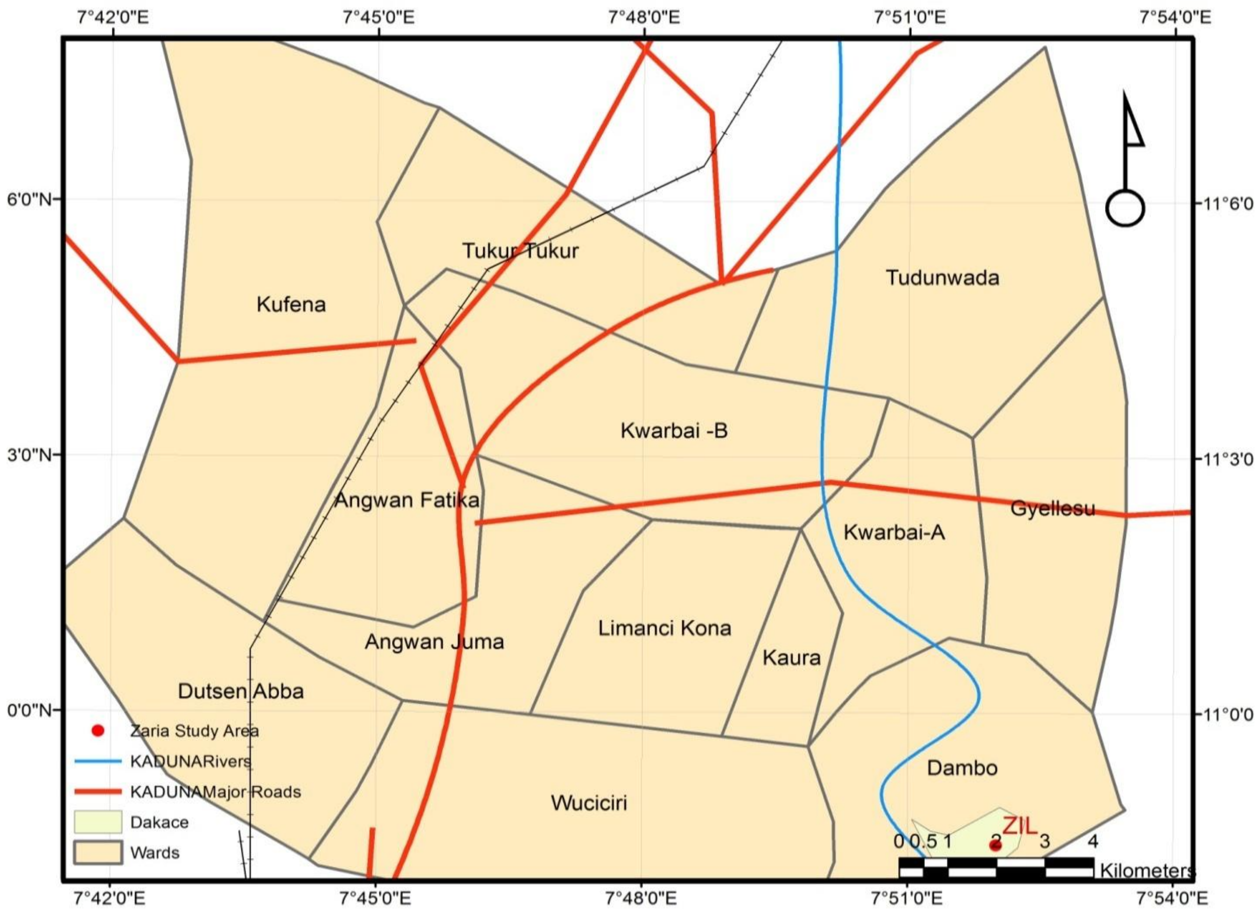

FIG.3.2: ZARIA INDUSTRIES NIGERIA LIMITED WITHIN IMMEDIATE ENVIRONMENT
Source: Kaduna State Ministry of Lands and Survey, 2013

The other air mass is from the south, over the Atlantic Ocean which is moist, cool, and called Tropical Maritime Air Mass (MTS). The weather depends on the air mass which covers the area and its depth (Hore, 1970).

3.1.3 Geology of Zaria

The geology of the Zaria region is made up of crystalline metamorphic and igneous rocks of Precambrian to lower palaeozoic age occurring on the basement complex. A major part of the rocks is of high grade metamorphism mainly gneisses which suffered intense folding and granitization and have remained stable for millions of years. Others are migmatites, older granites and more recently metasediments (quartz, schist, laterites and aluminium). The rate and depth of weathering is quite irregular with variabilities but thorough, ranging from as deep as 60m to as shallow as 10m. The nature of parent material and long period of weathering under tropical conditions have produced a characteristic topography of peneplain, inselbergs and domes of resistant basement rocks. A combination of topography and geology more or less control the ground water occurrence in this area (Wright and McCurry, 1970).

3.1.4 Drainage System

The drainage system focuses on three major rivers; the Galma, Kubanni and Saye river basins. The Galma river and its tributaries are mostly ephemeral or seasonal in character and their flows are highly irregular (i.e. drying up from January to June) following rainfall events in streams such as Kabanni and Saye. The Galma river area belongs to the northeastern part of Kaduna river basin which borders the Chad basin to the north. The Galma River is one of the main tributaries of Kaduna River. It has headwaters near the northwestern edge of the Jos Plateau and falls near the Magami village (Ali, 1995). The Drainage is commonly dendritic because there is no structural control on the drainage lines on the deeply weathered plains. The channel patterns of the drainage basin are of types, those with large number of un-branched first order tributaries with high stream frequencies and drainage densities such as Awai, Maramara and kubanni to East of Zaria (Urquhart, 1976).

The relief of Zaria region is a plain, extensive gentle rolling peneplain which extends from Sokoto to Lake Chad and northward from south of Kaduna to Tugueddi scarp near Agades (Niger Republic). This cuts across most of the northern Nigeria and has been correlated with the mid tertiary African planation surfaces, recognized in other parts of the continent. The plain varies in height, reflecting both regional slopes to the south and a local relative relief of 30m-

46m. The plain is intermittently dotted by rocks, inselbergs and lateritic iron stone-capped mesas, with the prominent landmark of Kufena (Thorp, 1970).

3.1.5 Soil

Zaria soils falls within the ferruginous tropical soils. The soils are deeply weathered with fine particles up to 50m deep (Jackson, 1958). A typical soil profile of the study area shows that the lower part of the underlying soil consists of mineral materials from the weathered gneisses and still has some pieces of quartz and mica. The upper layer is a mixture of some materials together with blown (wind-blown) particles. The profile also indicates an accumulation of clay between a depth of 36cm and 119cm (Jaiyeoba, 1986). According to Jaiyeoba (1986), below the horizon of clay accumulation, there exists another horizon which is of iron deposit. This is signified by the red or brown coloration; lower down is also found hard iron concentration. Though the soils of Zaria belong to the ferruginous group, those at the fadama (flood plains) belong to the hydromorphic type of soil which has high water retention capacity (Wright and McCurry, 1970).

3.1.6 Vegetation

The natural vegetation of the study area is the northern guinea savanna type. But the natural vegetation are absent within the vicinity of the gulley, resulting from the occurrence of the gulley itself due to poor vegetal cover, cleared for the purpose of cultivation, urbanization and construction of structures like the railway track. The land management practices have resulted in the evolution of thorny shrubs intersparsed with short annual grasses. The dominant shrub around the area is *Isoberlinia doka* with an average height of 20 metres. Other less frequent shrub species are *Butyrospermum spp*, *Piliostigma spp*, *Vitex spp*, *Terminalai spp* and *Dichrostachys spp* (Jackson, 1970).

The common grass communities around the study area are mostly *Andropogoneae* such as *Hyparrhnia spp*, *Andrpogon spp*, *Schizachyrium*, *Semi-berbe* and *Monocymbium ceresiiforme* and are almost completely absent during the long dry season. However, as soon as the rainy season begins grasses sprout and shrubs germinate very rapidly, no sooner had they become well established than the rain comes to an end again. Extensive grazing also contributes to the absence of grasses (Jackson, 1970). Tree plants include *Mangifera indica*, dotted everywhere, *Parkia clappertoniana* and several others that are useful to man. Despite cultivation activities going on, these are left standing. The vegetation is thick and greenish but dry and brownish during the wet and dry season respectively (Jackson, 1970).

The relationship of the physical characteristics of Zaria to the study is that waste materials (comprising plastics, sachet water bags, scrap metals, glasses, rags, paper, vegetal materials etc.) if left uncollected, block drainages especially the non-biodegradable waste materials thereby preventing rain water from percolating or infiltrating through the soil and these results in stagnant water which takes days for it to completely drains down into the soil. Areas that are water logged combines with waste materials most times traffic flow, serves as a good breeding ground for disease vectors like mosquitoes, rodents etc. and also contribute to bad odour and diseases like cholera diarrhea among others. Waste if not properly managed can pollute water bodies and in turn affects animals and agricultural land, and aid soil erosion.

3.1.7 Population

The population of Zaria according to the 2006 census figure, is 698, 348 (NPC, 2009). This figure makes Zaria the second most populated urban centre in Kaduna State. This population is shared by the two local government areas, that is, Zaria and Sabon Gari as shown in Table 3.1. Due to the fact that official population assessment in Nigeria reflects administrative boundaries rather than settlements, this population figure also captures rural areas that are at the periphery but whose jurisdiction falls within Zaria and Sabon Gari Local Government Area Councils.

Table 3.1: Population of Zaria

Local government area	**Sex**				**Total population**	**Total**
	Male	**(%)**	**Female**	**(%)**		
Sabon Gari	149,111	41.4	142,247	42.0	291358	41.7
Zaria	210,900	58.6	196,090	58.0	406990	58.3
Total	360011	100.0	338337	100.0	698348	100.0

Source: NPC (2009).

Zaria is an important nodal point for both the railway and the road systems. It is connected to the northern and southern parts of Nigeria by road and railway. This nodal position in the national transportation system has attracted commercial, administrative and educational institutions to it. This causes a substantial expansion of Zaria. In this connection, there has been an increase in Zaria's population as a number of immigrants from other parts of the country are attracted to it. Thus, increasing the volume of solid waste generated in the study area; since population growth and increased urbanization results in a corresponding increase in the amount of solid waste generated.

Zaria Local Government Area (where in is located ZIL) is the second most populous local government area in Kaduna state and has the largest number of settlements in Zaria, also characterized by lots of commercial activities. The total population of Zaria Local Government Area is 406, 990 persons with the male population making up to 210, 900 and females 196, 090 respectively (NPC, 2009), it has lots of public and private institutions, large market, industries, etc. which could be the reasons for the high population and the commercial activities (Stanley *et. al*., 2012).

3.1.8 Urban Structure of Zaria

The present day Zaria is formed by four distinct urban sectors- Zaria City, Tudun Wada, Sabon Gari and Samaru (Fig.3.1 and 3.2)

Zaria city, which is the headquarters of the Zazzau Emirate, lies in the south of Zaria. The original walled city retains much of the physical character of the traditional indigenous settlement of Muslim Hausa-Fulani population. The city still has a traditional character of perimeter wall, a complex maze of mud –walled compounds, and major roads secured by gates (*kofas*) leading to the Emir's palace, the Friday mosque, and the market area.

Tudun Wada is situated immediately north of the main city gate. It was the original strangers' quarters for non-natives of northern Nigerian origin. In recent times, however, Tudun Wada is inhabited by a more mixed population. Tudun Wada is characterized by a mixture of modern and traditional architecture with a street system in grid-iron pattern. It is in this quarter that most of Zaria's academic institutions are located. Several expansions have been made to Tudun Wada as it now extends to Gaskiya, and Tudun Jukun.

To the north of Tudun Wada lies Sabon Gari. Sabon Gari was created by colonial policy to accommodate strangers from the southern parts of the country. This is a recent quarters in Zaria and was built after the railway reached Zaria in 1911. It houses immigrants of mixed cultures and religions. Sabon Gari was laid out on grid- iron street pattern, which is indicative of an attempt at planning. The area is characterized by medium and low density residential plots.

Later, areas like Muchia, Chikaji and Dogon Bauchi sectors were engulfed by development. Adjacent to Sabon Gari lies the Government Reservation Area (GRA). It is characterized by West European oriented urban design pattern. The roads are properly laid out, plots are mainly of low density and there are a lot of organized open spaces.

The Sabon Gari area was zoned for residential, commercial, industrial, health, education, and recreational uses. This district has now transformed to become a commercial and entertainment centre of Zaria. The GRA was originally reserved exclusively for the British administrators but indigenous officers now occupy the area. It has the Zaria club, the polo field, race course and the Golf club situated in it. After the GRA, moving northwards are a few indigenous settlements of Kwangila, Hanwa, and Dogarawa.

Samaru is in the northernmost section and is the most recent addition to Zaria Urban Area. It is a religiously and culturally mixed settlement. Samaru evolved from a small colonial farming settlement into a large community. Samaru village owes its growth to the influence of Ahmadu Bello University and the Institute for Agricultural Research. The settlement is inhabited mostly by people working in the University. The settlement has expanded overtime to include other settlements like Zango, Palladan, Layin Zomo and Bomo (Ukoje, 2011).

3.1.9 Socio-Cultural and Economic Characteristics

The composition of Zaria population is less heterogeneous than that of Kaduna or Kano. However, Sabon Gari and Samaru population are more heterogeneous in character. The sectors of the town are activity specific. The indigenous small-scale craft industry has been traditionally well developed. It is owned by a system of interdependent family enterprises. This is especially evident in the Zaria City, where small groups of tanners, leather works, dyers, potters and blacksmiths are found normally concentrated in a small cluster of adjacent compounds in the wards of the city. These crafts are handed down from one generation to another. Light industries are concentrated in Tudun Wada and Sabon Gari districts. In these districts, most of the firms and a number of the widest range of modern crafts and small industries are located. The modern crafts include tailoring, barber shop, silver smiths, carpentry etc. (Sokomba, 1980).

Education constitutes an important activity in Zaria and this gives a distinct character to the urban settlement. It adds to the cosmopolitan character of Zaria and the morphological diversity it has occasioned. The concentration of educational activities in Zaria has considerably diversified the composition of its inhabitants by bringing together people of different nationalities and ethnic groupings.

Most households in Zaria where ZIL is located live in compounds with an average of 9(nine) people per household and a compound size of 22 (twenty two) people (Sani, 2006).

The industrial waste characteristics of the study area comprises of two distinct types of waste namely; liquid (effluent), and solid waste which are generated and presented to the environment as a result of industrial processing of raw materials into finished goods for human consumption.

3.2 METHODOLOGY

This section discusses the various methods that were employed in generating data for the study. The section focused on the types of data used, the sources of data, the sampling design, and the methods of data analysis. Reconnaissance survey has been conducted to provide adequate understanding of the study area.

3.2.1 Types of data

(i) types, sources and destination of waste generated by ZIL.

(ii) existing waste management practices of ZIL and

(iii) acceptable information standard for waste management by textile industries.

3.2.2 Sources of data

3.2.2.1 Primary source of data

The researcher employed the use of key informant interview (KII) in eliciting information for the research. These contained relevant and well structured questions aimed at eliciting responses that addressed the objectives of the study. The checklist used contained both open and closed ended questions to obtain detailed information. Furthermore, Questionnaire and structured interviews as well as, informal discussions and observations were used to collect data from individuals within 20km radius of ZIL; in order to give an understanding of both the activities of the industry that extends to its surrounding and the effects of waste generated if any exist. The field/ laboratory work was conducted within a period of five weeks. Direct interactions were made with respondents to reveal additional vital information that was not part of questionnaire-interviews. In addition, observation of the activities carried out by the personnel's in the industry including other activities outside the industry was used to verify the facts of the respondents. Interviews were conducted in both English and local language Hausa- which is the widely spoken language in the study area.

3.2.2.2 Secondary source of data

The secondary data used by the author was actually from publications of ministries of environment and related agencies. Organizations such as United Nations, WHO, National Bureau of Statistics and related multilateral corporations etc.

3.2.3 Sampling technique and sample size

The sampling frames are the key informants identified in ZIL. This study on the assessment of waste management practices in ZIL adopted the modified methods of Townend and Cheeseman (2005), UNEP (2005) and WHO (2005). Zaria Industrial Limited, Dakache selected is a major company with large scale producing machines for tarpaulin and allied fabrics. An inventory of the waste generated in various sections of the industry; bleaching, sizing, dyeing, was obtained using an inventory form (UNEP (2005) and WHO (2005)). The different types of effluent generated were collected using separate specimen bottles which were then weighed. The quantity of effluent generated was weighed prior to disposal and recorded in the inventory form. The quantity of the different categories of effluent waste was deduced by estimation while the type of waste will be identified through direct observation.

Using a list obtained from the personnel department of the company, a total of 20 skilled and 32 unskilled factory staff respectively were randomly selected for questionnaire administration. To understand the overall waste management structure of the industry, the researcher conducted key informant interview with the head of the company's administration. The main questions asked were: (a) Industry waste management policy; (b) Budget for waste management; (c) Training of waste management staff.

An overall performance rating was assigned using the approach outlined in the guidelines suggested by Townend and Cheeseman (2005). This guideline uses a simple table format that links performance with a set of criteria to assess the level of sustainable development associated with the company. Based on this guideline, industries can be grouped into 4 different levels of sustainable practice based on the characteristics described in Table 3.1.

The study also covered the residents within 20km radius in Dakache as part of the sample frame. The number of questionnaire used was based on the population of the study area. To determine the sample size for these, Krejcie and Morgan's (1970) method of determining sample size was adopted which states that; for an area with a population between 5, 000-7, 499, the sample size to be used is 252. Since the estimated population of the study area is 5, 046 (NPC, 2009) which fall between these ranges, the sample size of 252 is in order. This amounted to about 5.0 % of the sampled population 5, 046. Farms and soil samples within 20km radius of ZIL were also units of observation for detailed information about the study area.

Lastly, for the laboratory analysis, due to high cost in running laboratory analysis; only few samples each of the different types of effluent was collected using specimen bottle at some selected points i.e. within the industry (source) and at the disposal points (river/farmland) of the effluent and was tested in the laboratory for key physico-chemical parameters such as biochemical oxygen demand (BOD) and chemical oxygen demand (COD) in streams, well and soil.

Table 3.2: Guidelines for the assessment of level of sustainable waste management practice.

Sustainable level of practice	Operating performance	Characteristic
Level 0	Operating in a totally unsustainable manner with reluctance to change	No waste management strategy, only limited segregation of wastes, storage containers are unspecific with no color coding and waste likely to be dumped outside the company building. In addition waste is transported in open trucks, limited re-use of materials and no recycling at the facility; waste treatment is limited to the simplest technologies such as crude incineration while if off-site disposal exists it will be mainly to a dumpsite or level 1 landfill with the attendant environmental hazards.
Level 1	Generally operating in an unsustainable manner, although there is some evidence of awareness and willingness to change.	Although having no specific waste management strategy, will have separate collection of segregated wastes in enclosed vehicles, autoclave o f infectious waste and use single cell incineration plant.
Level 2	Operating in a manner with some aspects that are considered sustainable and others that are considered unsustainable	Waste management policy in place, segregation of wastes and color coding, specified waste storage containers, waste transported with enclosed compaction vehicles and separate vehicles for hazardous waste, some recycling at facility (paper, cardboard etc), use of multi chamber incinerator plants and alternative modern technologies (such as microwave) to treat waste and disposal in level 2 landfill.
Level 3	Generally operating in accordance with sustainable development, but some aspects not ideal	Local waste management policy and strategy in place, full color coding, dangerous goods are stored in UN approved containers and packaging all waste in containers of approved standard and a dedicated waste handling facility. Re-use and re-cycling of materials (example, print cartridges, oil), incineration of hazardous materials to EU Directive emission standards plus use of alternative technology and offsite disposal at a level 3 engineered landfill site
Level 4	Operating in a way that displays all the characteristics normally associated with sustainable development	Waste management policy, full time waste manager, full segregation of materials, full color coding, contracts with secondary raw materials industry, storage in UN approved containers, all wastes in containers or sacks to approved standard and a dedicated well secured waste facility. Waste is transported in enclosed compaction vehicles, Basel convention applied to waste transport. Recycling of paper, glass, plastic, metal, construction waste, food waste, textiles etc. incineration of hazardous materials to EU Directive emission standards plus use of alternative technology, hazardous waste to strictly controlled landfill sites and offsite disposal to level 4 engineered sanitary landfill.

Source: Modified from Townend and Cheeseman (2005) by author.

3.2.4 Techniques of data analysis

Data for the analysis was extracted from the inventory form and personal interviews conducted by the researcher. The waste management performance of the industry was assessed using a checklist consisting of six characteristic waste management descriptors and 27 indicators of integrated solid waste management. As presented in Table 3.1, these include: (i) General management strategy; (ii) Waste collection; (iii) Waste segregation; (iv) Waste recycling/reuse; (v) Waste storage; (vi) Off-site disposal.

Analysis and presentation of information from the questionnaire was done by means of descriptive and inferential statistics. Checklist data was further compared with findings from the study and thus represented in form of statement/tables. For descriptive statistics; the data were summarized and presented in tables, charts, percentages etc. All statistical analysis was done using Statistical Package for the Social Sciences (SPSS 17.0 version).

CHAPTER FOUR: PRESENTATION OF RESULTS AND DISCUSSION OF FINDINGS

4.1 SOCIO-ECONOMIC AND DEMOGRAPHIC CHARACTERISTICS OF RESPONDENTS

A total number of 200 respondents comprising dry/rainy season farmers and settlers around the ZIL were involved, with 52 respondents from the industry which gives a total of 252 respondents. Socio-economic characteristics have inference on how people respond to waste and were discussed under age, gender, educational and marital categories and religion. Other issues are occupation and environmental implication of industrial effluents.

4.1.1 Age of respondents

Based on the study, it was established that majority of the dry/rainy season farmers and settlers about 48.8% within the 20km radius of ZIL were youths of ages between 20-35 years. Those between 40-45 years, 50-55 years account for 36.1% and 8.3% respectively. While the least is 6.8% which covers 60 years and above.

Table 4.1: Age of respondents

Age	No. of respondents	Percentage (%)
20-35	123	48.8
40-45	91	36.1
50-55	21	8.3
> 60	17	6.8
Total	**252**	**100**

Source: Field survey (2014)

All age groups are represented (i.e. children from 5-17 years) they do assist their parents or elder ones on the farm most times, and it is a known fact that such category are highly susceptible to diseases like diarrhea and pneumonia, since they do drink water from the well/stream around and are also exposed to cold water during irrigation. The industrial staffs were also between the ages of 20-35, 40-45 years (Table 4.1).

4.1.2 Sex of respondents

The survey shows that about 79.4% as against 20.6% of the respondents were males who were mostly involved in activities such as farming, fishing among other that relates to the study. Females are only engaged in activities like buying and selling of produce from farmers, examples include; maize, fish, cabbage, carrot, tomatoes etc. the females comprises both young and old.

PLATE I: Carrot buyers washing and packaging the produce cultivated around 20km radius of ZIL

It is a known fact that crops utilizes water and nutrients from the soil, the Total solids (TS) and Total dissolved solid (TDS) generated by ZIL gets to water bodies and soil and are absorbed alongside the useful nutrients by plants thus when such produce are consumed by humans are harmful to their health (see plate I).

4.1.3 Religion of respondents

The religion of majority of the respondents both at their settlement and on the farm around ZIL is Islam. About 87.3% were Muslims while about 12.7% of the respondents are Christians especially at the settlements. This is a reflection of the religio-cultural attribute of Zaria and/or the closeness of where the industry is situated (Dakache) to Zaria city, indicating the dominance of Muslims in the informal economy by their size in the population composition.

4.1.4 Ethnic group of respondents

Ethnic group categorization in figure 4.1 revealed that Hausa/Fulani is the major ethnic group among the respondents, with 78.6% (198). The high proportion of these ethnic groups perhaps signifies their exposure to benefits attached to dry/rainy season farming.

PLATE II: Buyers and sellers comprising individuals from different ethnic groups obtaining produce cultivated within the 20km radius of ZIL

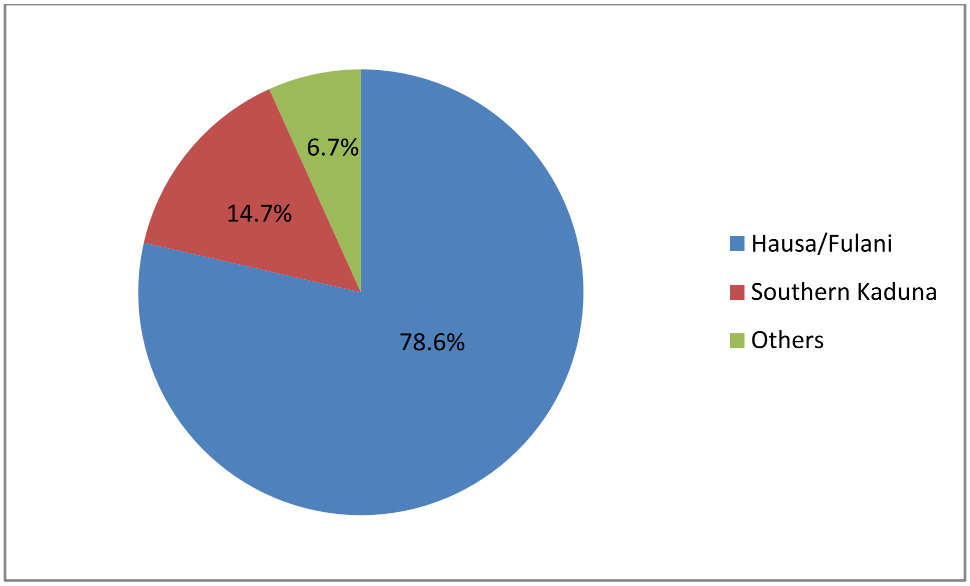

Figure 4.1: Ethnic group of respondents
Source: Field survey (2014)

Atiyap and Chawai (from Southern Kaduna) were next in terms of proportion in crop business which accounts for 14.7% (37). Others like Edoma, Igala, Yoruba etc. account for 6.7% (17) who don't partake in the actual agricultural activities but they are involved in buying the farm produce either for their personal consumption or for sale to other buyers. The consumers of such product are mostly from within and outside Dakache (see plate II).

4.1.5 Educational qualification of respondents

Figure 4.2 shows the educational qualification of the respondents both at ZIL, settlements and on the farm lands. It shows that majority of them generally have low levels of formal education. In fact, 56.7% of the respondents claimed that their highest level of education is Quranic education compared to the least 6.3% that have acquired tertiary education (which was actually from some of the residential areas around ZIL and staffs of ZIL). Those with primary education accounts for 15.9%, while respondents with secondary education were 7.6%, about 13.5% of the respondents have no formal education.

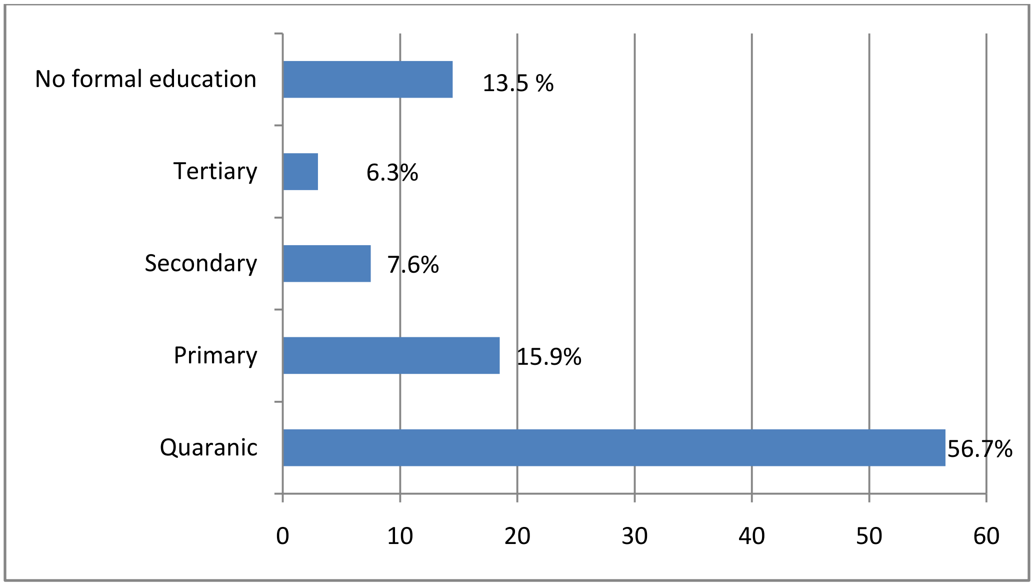

Figure 4.2: Educational qualification of respondents
Source: Field survey (2014)

This lack of formal education also predisposes them to making a living from farming, a primary activity which can be highly affected by pollution and waste contamination at the local scale like that of ZIL. It is interesting to note that, low educational level of the respondents indicates that formal educational qualification is not a key determinant for engaging in this type of business.

4.1.6 Secondary Occupations of respondents

As regards other occupations when inquired, Table 4.2 shows that a relatively high proportion (60.7%) of respondents were engaged in other occupations like commercial motorcycling (Achaba), butchering, casual/industrial work, security service, etc. while 39.3% were not engaged in other occupations apart from farming activities (see plates III, IV and V).

Table 4.2: Secondary occupations of respondents

Secondary occupation	No. of respondents	Percentage (%)
Commercial Motorcycling	58	23.0
Butcher	17	6.8
casual/industrial work	50	19.8
security service	28	11.1
agricultural activities	99	39.3
Total	**252**	**100**

Source: Field survey (2014)

PLATE III: Onions as one of the crops produced within the 20km radius of ZIL

PLATE IV: Cabbage produced on one of the farm land around ZIL

PLATE V: Farmers harvesting carrot cultivated within the 20km radius of ZIL to be sold to buyers within and outside Zaria

This is a clear indication that the benefits derived from agriculture for the respondents cannot be over emphasized thus the need to thoroughly investigate the quality of soils, streams, crop produce and even plant/animal lives within and beyond the 20km radius from ZIL.

4.1.7 Farming practice of respondents

Field investigation revealed that about (215) 85.3% of the respondents do cultivate crops during dry/rainy season in contrast to about (37)14.7% of the respondents who were not involved in dry/rainy season farming. These groups are basically those that are just residents within the 20km radius of ZIL.

Table 4.3: Possible damages by effluents as opined by respondents

Damages	No. of respondents	Percentage (%)
Toxic substances by plant	22	8.7
Pollute farm land	26	10.3
Destruction to plants/animals and humans	39	15.5
Degrades farm lands	165	65.5
Total	**252**	**100**

Source: Field survey (2014)

PLATE VIII: Farmers trying to revive a degraded farm land as a result of industrial effluent around ZIL

Plate IX: A degraded farm land abandoned for more than 5 years as a result of industrial effluents

Furthermore, as regards the possible damages to both plants/animals and farm lands, majority of about 66% of the respondents said it pollutes and degrades farm lands while 10%, 16% and the least of about 9% of the respondents were of the view that effluents can pollute farm land, heavy chemicals from effluents can damage plants and at a very high dose, can also kill both humans and animals. Lastly plants do absorb toxic substances presented to them from effluents respectively (see plate VIII and IX).

4.2 TYPES AND SOURCES OF WASTE FROM ZIL

4.2.1 Sources of waste

Industrial wastes as far as ZIL is concerned are generated from various sources ranging from the processing plant, store house, administrative offices, temporal dump site within ZIL. All the 52 respondents sampled within the company claimed that the waste materials comprises; wastewater (effluents), sludge which are the major waste produced by ZIL, others include; pieces of wood, plastics, glass, scrap metals, Card board, Carton, cotton etc.

However, the respondents disclosed that reuse/recycling of effluents among other materials are actually not carried out in the industry.

Consequently, about 95% of the respondents within the 20km radius of ZIL disclosed that the industry is a major source of waste since varieties of waste i.e. sludge, some quantity of effluents, plastics, scrap metals etc. as earlier mentioned are still disposed of within the said radius. This in turn becomes a nuisance to both farmers and settlers, damage to crops within the area. Carbon monoxide (CO) is another form of waste ZIL emits from generating plant during tarpaulin processing thus causing a serious health implication to both ZIL staffs (those without protectors) and residents around the company.

4.3 ENVIRONMENTAL IMPLICATION OF EFFLUENTS

4.3.1 Disposal points for ZIL effluents

From the findings, about 74% of the respondents admitted that they knew about the disposal point where the industry discharges of its effluents which is their farmlands. They were of the view that the effluents from ZIL passes through a channel into their farmlands then drains/flows till it get emptied into *rafin Dakache* (see plate VI and VII).

PLATE VI: Previous effluent channel from ZIL to farm lands/streams within the 20km radius of ZIL at Dakache (poor management practice).

PLATE VII: *Rafin Dakache* where ZIL effluents were previously emptied at Dakache, Zaria.

However in the last 10-15 years they claimed that the effluent stopped flowing through the channel created by the company into their farmlands. They also pointed out that channeling the effluent into farmlands and water bodies is now been replaced with a suck away dug within the company where the effluents are stored. In addition, the respondents noted that a company like Sun seed a neighbor to ZIL still disposes of her effluents in streams around the industries. Furthermore, 11 farmers who were matured in age disclosed that around 1985, the chemicals which the effluent is composed of when released into water bodies negatively affected both plants and aquatic lives, it also brought about water logging and bad land (soil infertility). From the analysis, about 26.5% of the respondents in the study area were also of the view that they were told same as earlier stated above by their parents and senior colleagues in the farming business.

All the respondents claimed that they don't have the knowledge whether there was an order from the government which led to the alternative presently utilized by the company or the company on its own decided to come up with such an option (i.e. the suck away). However, that to the best of their knowledge, the government has not in any way come to their aid in terms of regular treatment of water bodies; diversion of effluents channels from reaching farm lands; weekly scooping of effluents among others.

4.3.2 Awareness of harmful properties of Industrial effluents among respondents

Field investigation revealed that a greater percentage (about 65%) of the respondents noted that when effluents from any industry like ZIL is discharged into the environment, it contains substances such as harmful chemicals, particles of metal, and other materials. While approximately 13% of the respondents claimed to have noticed only harmful chemical, close to 9%, to a little bit lower than 6% of the respondents claimed to have observed mainly litter and particles of metal respectively.

Table 4.4: Awareness of physical attributes of Industrial effluents among respondents

Harmful substances	No. of respondents	Percentage (%)
Harmful chemicals	32	12.7
Particles of metals	16	6.4
Litter	22	8.7
All of the above	163	64.7
No response	19	7.5
Total	**252**	**100**

Source: Field survey (2014)

On the other hand about 8% of the respondents claimed to be completely not aware of any harmful substances as part of the constituent of effluents. These may be due to lack of formal education or exposure in ability to recognize waste and the physical properties. From the findings, majority of the respondents were aware of some environmental negative effect (Table 4.4).

4.3.3 Knowledge about effluents as threat to the environment

Field investigation further revealed that majority (about 79%) of the respondents were knowledgeable of the fact that industrial effluents if left on the environment without proper check or disposal will become a serious threat not only to the environment but also to human beings, plant/animals, properties etc. Whereas, about 21% of the respondents were of the view that they are not aware of the possible harmful substances/effluents being a threat to the environment (Table 4.5).

Table 4.5: Knowledge of waste as a threat to the environment

Threat	No. of respondents	Percentage (%)
Cholera	41	16.3
Typhoid	37	14.7
Litter, Canser and dysentery	23	9.1
Choking of drainages by Litter	14	5.5
Destruction to plants and aquatic lives	19	7.5
All of the above	109	43.3
No response	9	3.6
Total	**252**	**100**

Source: Field survey (2014)

Table 4.5 further revealed that as high as 43% of the respondents were knowledgeable about all the possible threats (blockage of drainages by litter, diarrhoea, Cholera, Typhoid etc.) while about 6% constitute respondents that were aware of the threat to be in form of Choking of drainages by litter. About 9% of the respondents were only aware of the consequences to be blockage of drainages by litter, cancer and dysentery, 16% Cholera only, 15% Typhoid, 8% destruction to crops and aquatic lives, lastly about 4% of the respondents were not aware of the threats to man when exposed to waste. This implies that an industrial activity that has to do with effluents is actually a practice that is not environmental friendly.

More so, in consonance with the respondents' claims, Ovayoza, Otubor, and Olorunfemi (2015) in their work on the evaluation of some industrial effluents in Jos Metropolis, Plateau State, Nigeria, revealed that discharge of industrial effluents into the receiving environment invariably results in high concentrations of microbiological, chemical and physico-chemical pollutants. The authors observed high presence of COD and BOD levels found within the industries and its environs, and also high levels of total suspended solids (TSS), total dissolved solid (TDS) sulphide, iron and lead observed in all the industries. They noted that pollutants also have negative impact on these environments where they may harm crops, animals and humans in various ways. Trihalomethanes (THM) are environmental pollutants from industrial effluents and many are considered to be carcinogenic. Nitrates play a major role in the promotion of growth of aquatic plants and algae but may also cause methemoglobinemia if ingested from vegetables or contaminated water (Addiscott and Benjamin, 2004).

4.3.4 BOD and COD for Stream, Wells and soils within 20km Radius of ZIL

Water from streams, wells and soils within the 20km radius of ZIL was sampled and the laboratory result revealed that the biochemical oxygen demand (BOD) was found to be 10 mg/l, 12 mg/l and 7 mg/l for stream water, well water and soil respectively which is below World Health Organization (WHO) and National Environmental Standards and Regulations Enforcement Agency (NESREA) standard for a normal stream, well and soil quality. This invariably means that activities of bacteria utilize a reasonable amount of oxygen making aquatic life difficult in terms of survival from the stream water sampled (see Table 4.6).

Table 4.6: Relationship between BOD and COD for stream water sample, sample of well water and soil around ZIL

Physicochemical Parameters	WHO Acceptable Limit (mg/l)	NESREA Acceptable Limit (mg/l)	ZIL Stream Water Sample	ZIL Well Water Sample	ZIL Soil Sample
BOD	15	30	10	12	7
COD	40	80	95	89	92

Source: Author's laboratory analysis (2015)

The BOD for the wells sampled as earlier mentioned was also less and not within the acceptable limit of WHO and NESREA standards. This translates to water not actually safe for human consumption because of the low oxygen demand. Furthermore, for the soil; the oxygen demand is also found to be low thus soil organisms thrives to survive under such condition thereby affecting the yield in the area. It is a known fact that soil organisms facilitate the uptake of soil nutrients by plants. Under such condition, good aeration by plants will actually tend towards zero.

Chemical Oxygen Demand (COD) on the other hand was found to be above WHO and NESREA acceptable limit for the variables- Stream water, Well water and Soil. The COD also exceeded the BOD of the same units tested. Laboratory analysis revealed that the COD for the stream water was 95 mg/l, 89 mg/l for well water while soil was found to be 92 mg/l within and around the said radius of the industry. The result simply means that the COD is higher than the BOD in all the mediums; these will actually pose serious challenge not just for plants, soil microbes, but including aquatic organisms, animals and human beings especially those consuming water from the stream and well and also for other domestic activities. This in line with findings of Bernard, (2010) in a work on the performance of wastewater treatment plant and its effect on water quality of the Oda river in Kumasi, Ghana. In that study Bernard reported that the COD for water sample obtained from the river was 282 mg/l, thus did not meet the recommended standard of 250 mg/l from Ghana Environmental Protection Agency (EPA, 2001), and was also higher than the BOD value which was 14 mg/l and the EPA standard for the BOD is expected to be 50 mg/l.

4.4. COMPARISON OF WASTE MANAGEMENT PRACTICE AT ZIL WITH INTERNATIONAL STANDARD

Field survey disclosed that waste management practices at ZIL do not conform fully with international best practice, their practice include; transportation of waste materials using open trucks, dumping of waste on unauthorized landfill and partially practice segregation especially during the mandatory stages of textile processing. The best practices notable of which are; Waste management strategy, Segregation of waste, Re-use of materials, Recycling of Materials, Treatment of waste e.t.c. are actually not observed by ZIL (Tables 4.7 and Table 4.8).

Close to 83% of the respondents were of the view that the company does generate waste like: solid, liquid effluents and sludge and also do not carry out re-use/recycling activities, since such facility does not exist in the industry. As regards the mode of waste transport; its strictly the use of enclosed compact vehicle to convey waste to disposal point (landfills). Furthermore, about 75% of the respondents asserts that the mode of waste treatment is basically off-site disposal, also the industry segregate of her waste alongside sludge evacuation using enclosed vehicle as earlier stated but the company do not practice color coding in the process of segregation of waste. It is interesting to note that all the respondents including the waste Manager admitted that storing of dangerous goods in UN (United Nations) approved containers and packaging in a dedicated waste handling facility is actually not applicable in ZIL. In contrast, ZIL practices is actually not in line with the international best practice on the basis of the KII conducted and such practice falls under level zero (1) (see Table 4.8).

Table 4.7: Checklist parameters and its corresponding practices

Checklist	**Standard practice**	**Waste Management Practice of ZIL**			**Score**
Practice(s)	Complete (10)	None	Partial	Complete	
Waste management strategy	10	0	-	-	0
Segregation of waste	10	-	-	5	5
Storage containers with colour coding	10	0	-	-	0
Waste transported in open trucks	10	-	10	-	10
Re-use of materials	10	0	-	-	0
Recycling of Materials	10	0	-	-	0
Treatment of waste	10	0	-	-	0
Incineration plant	10	0	-	-	0
Authorized engineered landfill site	10	0	-	-	0
Unauthorized and open landfill	10	-	10	-	10
TOTAL	100				25

Source: Field survey (2014)

Score of checklist: Level 0= 1-20, Level 1= 21-40, Level 2= 41-60, Level 3= 61-80, Level 4= 81-100.

Table 4.8: Assessment level for ZIL as regards sustainable waste management practice.

Sustainable level of practice	**Operating performance**	**Characteristic**
Level 1	Generally operating in an unsustainable manner, although there is some evidence of awareness and willingness to change.	Although having no specific waste management strategy, will have separate collection of segregated wastes in enclosed vehicles, autoclave o f infectious waste and use single cell incineration plant.

Source: Modified from Townend and Cheeseman (2005).

As earlier stated in 4.1 factory staff which encompass skilled and unskilled were interviewed as regards the waste management structure of the industry. Mustapha Tanko claimed that waste management practice is not completely adequate simply because some of the effluents, solid waste, sludge etc directly or indirectly get to water bodies and soil still within or beyond the 20km radius of ZIL and all the respondents admitted that its subject to improvement over time.

CHAPTER FIVE: SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 SUMMARY

The aim of the study is to assess the existing waste management practices in Zaria Industries Nigeria, Limited. The objectives of this research are to: characterize the type and sources of waste in the industry; assess the environmental implication of waste management practices of ZIL; compare the existing waste management practice(s) in the study area with international best practice towards identifying gaps and proposing alternatives. A total of 252 Industrial workers, farmers and settlers around ZIL were studied using key informant interview (KII) and random sampling techniques. Tables, percentages and charts were used for the analysis.

The study established that majority of the respondents sampled were farmers and resident within 20km radius of ZIL and were youths of ages between 20-35 years old. The activity also involves young ones, so by implication are exposed to various diseases. Majority of the people engaged in most of the activities around ZIL as a result of the field investigation are of Hausa/Fulani ethnic composition with 78.6%. About 56.7% of the respondents claimed that their highest level of education is Quranic education compared to 6.3% that has acquired tertiary education and this figure was actually from some of the residence around the radius. Interestingly, the low educational level of the respondents indicates that formal educational qualification is not a key determinant before engaging in this type of business. A relatively high proportion (60.7%) of respondents were engaged in other occupation like Motorcycling (Achaba), Butchering, casual/industrial work, security service, etc. while 39.3% were not engaged in other occupations if not dry/rainy season farming amongst other agricultural activities.

Dry/rainy season as a practice is carried out by about 85% of the respondents and they do cultivate crops ranging from Onions, cabbage, carrot amongst other vegetables. They were of the view that industrial effluents pollute and degrades farm lands.

Majority of about 73% of the respondents claimed that they knew about the disposal point where the industry discharges of its effluents which is their farmlands then gets to streams. Not until of recent say 10-15 years when they found out that the effluent stopped flowing through the channel created by the company. They noted that the channel is been replaced with a suck away dug within the company where the effluents are stored. Eleven (11) farmers who were matured in age disclosed that around 1985, the chemicals which the effluent is composed of when released into water bodies destroyed/affected both plants and aquatic lives, it also brought about water logging and bad land (soil infertility).

The survey indicates that a greater percentage of about 65% of the respondents noted that when effluents from any industry like ZIL is discharged to the environment, it contains harmful substances such as harmful chemicals, particles of metal, among others. Notable threats may include: litter to the environment, diarrhoea, Cholera, Typhoid etc to human beings, destruction to crops and aquatic lives. About 76% of the respondent had an idea of the number of people that came up with some of the diseases.

Laboratory result revealed that the Biochemical Oxygen Demand (BOD) was found to be 10 mg/l, 12 mg/l and 7 mg/l for stream water, well water and soil respectively which is below World Health Organization (WHO) and National Environmental Standards and Regulations Enforcement Agency (NESREA) standard for a normal stream, well and soil quality. This invariably means that activities of bacteria utilize a reasonable amount of oxygen making aquatic life difficult in terms of survival from the stream water sampled. Furthermore, for the soil; the oxygen demand is also found to be low thus soil organisms thrives to survive under such condition thereby affecting the yield in the area. It is a known fact that Soil organisms facilitate the uptake of soil nutrients by plants.

On the other hand, the COD for the stream water was 95 mg/l, 89 mg/l for well water while soil was found to be 92 mg/l within and around the said radius of the industry. The result simply means that the COD is higher than the BOD in all the mediums; these will actually pose serious challenge not just for plants, soil microbes, but including aquatic organisms, animals and human beings especially those consuming water from the stream and well and also for other domestic activities.

Field investigation from Key Informant Interview (KII) revealed that waste management practice in ZIL is not completely adequate simply because some of the effluents, solid waste, sludge etc directly or indirectly get to water bodies and soil still within or beyond the 20km radius of ZIL. 83% of the respondents claimed that the company does generate waste like: solid, liquid effluents and sludge and also do not carry out re-use/recycling activities, waste disposal point is landfills. ZIL do not practice color coding in the process of segregation of waste and that storing of dangerous goods in UN (United Nations) approved containers and packaging in a dedicated waste handling facility is actually not applicable in the industry. From the findings, it is interesting to note that ZIL practice is contrary to international best practice on the basis of the KII conducted therefore, it needs to be amended.

The challenges militating against proper management of waste of any kind in ZIL are categorized into: lack of functional heavy duty machines; not imbibing the international best practice act; lack of technical personnel; and also support from the government in order to take ZIL among other industries that are operational to the next level.

5.2 CONCLUSION

By adopting the international best practices, ZIL will be recognized and also be able to compete with other known industries globally. It is a known fact that sludge and effluents from industries when properly treated can be used for re-use and irrigation purposes, such practice should be introduced in ZIL in order to alleviate the suffering of farmers within and around the industry during dry season. Government should also come to their aid so as to tackle the menace ravaging the company and farmers.

5.3 RECOMMENDATIONS

Since the Industry (ZIL) does use water in most of her activities, it is recommended that the company should imbibe or have a greater potential for internal reuse. Also, the high concentrations of toxic chemicals contained in wastewater produced in ZIL must be removed through intense physical/chemical treatment before it is channeled to the suck-away because the toxic substances may drain or pass through underground water and get to farm land and stream which will become poisonous to farm land, plants and aquatic lives.

Recommendations for further research are as follows:

i. In-depth analysis of soils and water (stream) of Zaria Industrial Layout, Zaria, Nigeria.

ii. Effect of Industrial Effluents on Crops from Agricultural Lands of Dakache, Zaria, Nigeria.

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APPENDIX

DEPARTMENT OF GEOGRAPHY, AHMADU BELLO UNIVERSITY, ZARIA

Dear respondent,

The purpose of this questionnaire is to obtain information on Waste Management Practices of Zaria Industries Nigeria Limited, Zaria, Kaduna State, Nigeria. Your answers will be confidential and strictly for academic use. I sincerely request your cooperation in completing this questionnaire. Please tick the appropriate option.

QC…………..

Location code…………..

SECTION A: DEMOGRAPHIC AND SOCIOECONOMIC INFORMATION

1. What is your age? ....

2. What is your ethnic group? (a) Hausa/Fulani ( ) (b) Igbo ( ) (c) Yoruba ( ) (d) Northern minority ( ) (e) Southern minority ( ) (f) Others (specify) ……………..

3. What is your religion? (a) Islam ( ) (b) Christianity ( ) (c) Traditional ( ) (d) Others (specify)……………..

4. What is your highest educational qualification? (a) None ( ) (b) Quranic ( ) (c) Primary ( ) (d) Secondary ( ) (e) Tertiary ( ) (f) Others (specify) ……………….

5. Are you engaged in other occupation? (a) YES ( ) (b) NO ( )

6. If yes, what type of occupation? (a) Farming ( ) (b) Civil/public servant ( ) (c) Student ( ) (d) Petty trading ( ) (e) Industrial operative/ casual worker ( ) (f) Others (specify) …………

SECTION B: INFORMATION ON THE STATE OF THE ENVIRONMENT

7. Do you have an idea of where the industry disposes of its effluent? (a) Yes ( ) (b) NO ( )
8. If yes, Where? (a) Dumpsite ( ) (b) Stream ( ) (c) Canal ( ) (d) Farm land ( ) (e) Others (specify)…………………………
9. Does the government in any way help in curtailing the effluents in your area? (a) YES ( ) (b) NO ( )
10. If yes, how? (a) Regular treatment of water bodies ( ) (b) diverting of effluents channels from reaching farm lands ( ) (c) weekly scoping of effluents ( ) (d) Others (specify)…………………………
11. Is there any form of harmful substances presented to the environment when effluents are released? (a) YES ( ) (b) NO ( )
12. If yes, what are they? (a) Harmful gases ( ) (b) Particles of metal ( ) (c) Litter ( ) (d) All of the above ( ) (e) Others (specify)………………………….
13. What type of illness do you think effluent can cause? (a) Diarrhoea ( ) (b) Cholera ( ) (c) Typhoid ( ) (d) Cancer ( ) (e) Dysentery ( ) (f) Others (specify)………………………….
14. Do you have an idea on the number of death recorded as a result effluent from ZIL? (a) Yes ( ) (b) No ( )
15. If yes, how many? (a) 1 ( ) (b) 2 ( ) (c) 3 ( ) (d) 4 ( ) (e) Others (specify)………………………….
16. What illness resulted to the person(s) death? (a) Diarrhoea ( ) (b) Cholera ( ) (c) Typhoid ( ) (d) Cancer ( ) (e) Others (specify)………………………….
17. Do you practice dry season farming? (a) Yes ( ) (b) No ( )
18. If Yes, what are the possible damage do effluents cause to both humans and land (a) It pollutes the land ( ) (b) Degrades land ( ) (c) Plants absorbs toxic waste substance from

effluent waste ( ) (d) Heavy chemicals from effluent waste can damage plants and also kill both humans and animals ( ) (e) Others (specify)…………………………………….

SECTION C: INFORMATION ON THE LIVING CONDITIONS OF THE RESPONDENT

19. Do you wash your hands after handling waste material? (a) YES ( ) (b) NO ( )
20. If yes, how often? (a) On regular basis (b) once (c) twice (d) Occasionally (e) None of the above ( ) (f) Don't wash hands completely ( ) (g) Others (specify)………………………
21. Have you or your staff ever fallen ill at work place? (a) YES ( ) (b) NO ( )
22. If yes, what was the cause of the sickness? (a) Malaria ( ) (b) Diarrhoea ( ) (c) preventable diseases ( ) (d) Tetanus ( ) (e) Others (specify)…………………………
23. Do you and your staff use protectors while handling waste? (a) YES ( ) (b) NO ( )
24. If yes, which among this do you use? (a) Rubber hand glove ( ) (b) Leather hand glove ( ) (c) Rubber booth ( ) (d) Both rubber hand glove and booth ( ) (e) Both leather hand glove and rubber booth ( ) (f) None ( ) (g) Others (specify)……………………
25. If no, why? (a) It is not convenient ( ) (b) It is not available ( ) (c) Don't see the need ( ) (d) Others (specify)………………………

SECTION D: KEY INFORMANT INTERVIEW

26. Is your waste management practice sustainable and subject to change overtime?
27. Do you have a waste management strategy or policy in operation?
28. Type of waste dump?
29. Mode of waste transport?
30. Any re-use or recycle facility at the company?

31. Mode of waste treatment? (a) incineration at emission standards with multi-chamber incinerator plants (b) off-site disposal (c) Strictly controlled Landfilling sites.

32. Segregation of waste in enclosed vehicles and or autoclaves?

33. Segregation of wastes and color coding?

34. Storing of dangerous goods in UN approved containers and packaging in a dedicated waste handling facility?