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The Impact of Urban Livestock Waste on the Environment in Potiskum Town Yobe State, Nigeria

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Abstract:
Livestock provide essential commodities and services to the majority of the world's population. With an increasing number of people, livestock are increasingly held responsible for many adverse effects on human health. The aim of the study is to examine the management strategies applied by urban and pre-urban livestock producers and their resultant consequences on the land, water, and health of the general public, emanating basically from small land holdings in Potiskum. The objectives of the study are to identify the locations of major dumpsites close to water points and to assess pollution incidence as it relates to public health. Ten-five water samples and/or soil samples were tested in an analytical chemistry laboratory. To assess the level of toxicity, a microbial test was also conducted in Biological laboratory. In addition to this approach, a 200-meter buffer radius was created around each water point, and 6 livestock keepers (household heads) within it were randomly selected for interview using a questionnaire survey. Descriptive statistics were used with SPSS/PASW version 18.0, and the results were presented using statistical tools such as percentage computation, frequency distribution table, line, and bar graph, respectively. Findings revealed heavy metals were found above the recommended water drinking level of WHO and Nigeria's standards. These include Magnesium (0.98), Iron (4.900), Chromium (3.30), Copper (1.520), Cadmium (0.84), Sulphate (15.30), Nitrite (2.25), Lead (2.20) as opposed to the acceptable levels of 0.1, 0.1, 0.05, 0.2, 0.003, 100, 0.2 and 0.01. More than 60% of the respondent's views revealed that the sizes of their residential buildings where livestock were raised are less than ¼ plots with limited space for both humans and animals. The distance estimate between human habitat and that of livestock animals of 70% of the farmers is less than four meters (<4m) as opposed to the world standard of 50m. Findings also show that direct animal and human interaction has become a serious health issue as some effects of zoonotic diseases, which include cholera 7%, abortion 15%, diarrhea 31%, and typhoid 50%, have been mentioned among urban livestock farmers. Some of the effects were 37% land degradation, 22% deterioration of structures and 29% contamination of water, 40% noise pollution, and destruction of properties, among others. Therefore, the research recommends that livestock farmers should constitute part of the negotiation at the planning stage. Sitting and constructing sanitary landfills, monitoring the quality and nature of the groundwater reservoirs, and medical research on both the health of the animals and their owners are to be conducted by taking blood, urine, and stool samples to medical laboratories.

Keywords: *Chromium, land, laboratory, livestock, residential*

1. Introduction

The fact that most African cities have undergone rapid growth in the past seven decades, there is much concern over the causes and effects of the urban transformation and the ensuing social and ecological deterioration of the urban landscape Tanko (2002). It was projected by Food and Agricultural Organization (FAO, 2011) that West Africa will live in cities by the year 2050. As sub-Saharan cities continue to expand and leave their 'ecological footprints' (Rees, 1992) on their surrounding environments, urban fringes are being rapidly transformed with the intensifying competition for scarce resources, frequently resulting in the progressive degradation of the peri-urban environment. From independence to date, after oil, the major economic background of Nigeria is agriculture. Hamaduo A. et al. (2012) lamented that the contribution of the livestock sector to the agricultural gross domestic product is 49, and 44% for Nigeria, while the growth rate of regional animal production is estimated at 4% per year. The regional demand for livestock products is expected to increase by 250% until 2025 compared to 2005 (ECOWAS 2008). Given the current degree of urbanization of about 20% and an annual growth rate of the urban population of 5–7%, an important proportion of the total population of sub-Saharan will definitely live in cities. Graefe et al. (2008) reported that agricultural intensification would take place mainly in areas with good infrastructure and well-developed input and commodity markets, such as in and around urban centers. It is, therefore, a fact that livestock rearing has received little attention from research and development initiatives in urban areas. As contained in the International Symposium on Supply of Livestock products to rapidly expanding urban populations organized by FAO (1995), peri-urban and urban livestock systems were recognized as rather more relevant.

Kutiwa et al. (2010) reported that urban agriculture is widely practiced in West Africa but has been neglected for a long time by policymakers. The contribution of Urban and Peri-urban Agriculture (UPA) to food security, household income, and job creation has then been well-recognized, along with the environmental benefits and problems resulting from its practices (Cohen & Garrett, 2010). Also, the findings of the study conducted by De Zeeuw et al. (2011) revealed that livestock keeping constitutes an important part of UPA (urban and peri-urban agriculture) but has received less attention from livestock solid waste disposal in the environment. It is generally perceived that people with low-income levels degrade the environment by practicing improper solid waste disposal practices. Households with low-income levels are willing to practice proper waste disposal, but their economic hardship forces them to dispose of them indiscriminately. Research conducted by Medina (2002) also observed a significant relationship between a community's income and the amount of solid waste generated. This means that low- and middle-income households generate a high amount of waste. Waste generation and its disposal are greatly influenced by the household's level of income.

A study by Bandara et al. (2007) on household income and types of waste generated from animals noted that organic waste and waste separation is high among household with high levels of income. This may imply that high-income households could afford plenty of waste for a different waste generation but with proper disposal. For example, in Niamey, Niger, Graefe et al. (2008) reported that more than half of the households involved in UPA were rearing livestock. In Kano, Nigeria, Muhammad (2008) found that keeping livestock was a considerable source of additional income for civil servants and traders. Many more kinds of research have been carried out by drawing their conclusion that there is a significant growth in the numbers of urban households involved in livestock rearing and identified related constraints and opportunities (Cissé et al., 2005). With reference to the findings mentioned so far, this study will examine the management practice applied by livestock keepers and its resultant consequences on the environment and, as such, a threat to public health emanating basically from small land holdings in some selected wards in Potiskum town. However, in recent years a great deal of attention has been given to what the Brundtland Commission referred to as the great 'urban challenge' (World Commission on Environment and Development, 1987). Findings from Lynch *et al*. (2001), Mwamfupe (2000), Tacoli (1998), and Aldington (1997) have focused on many issues confronting the sustainability of urban and peri-urban areas.

Livestock provide essential goods (skin and hides) and services to the majority of the World's population. With an increasing number of people, the meat supply is projected to increase from 200 million to 310 million tons annually by the year 2020 (De Haan et al., 1996). The development of the livestock industry has led to pollution problems caused by the increasing amount of animal waste. Pollution is on the increase and has reached its peak in developed countries like Japan since 1973 (Harada, 1994). Rising affluence, particularly in developing countries where average real incomes have doubled since the early 60s, means that more people can afford the high-valued protein that livestock can offer. Loss of vegetation cover reduced biodiversity, soil erosion, compaction, and excessive runoff, often from overgrazing. High concentrations of livestock contribute to contamination of groundwater and soil pollution. Livestock can produce significant quantities of 'greenhouse' gases, thereby possibly contributing to global warming (Anon, 1982).

All stakeholders concerned with the safety and the beautification of our environment have come to realize the negative consequences of unlearned solid wastes found in residential neighborhoods, markets, schools, and central business districts in our cities. A United Nations Report (August 2004) noted with regret that while developing countries are improving access to clean drinking water, they are falling behind on sanitation goals. One of its summits revealed that The World Health Organization (WHO, 2004) and United Nations International Children Education Fund (UNICEF, 2004), in their joint report in August 2004*, said: "About 2.4 billion people will likely face the risk of needless disease and death by the target of 2015 because of bad sanitation*." The report also noted that bad sanitation decaying or non-existent sewage system and toilets- fuels the spread of diseases like cholera and basic illness like diarrhea, which kills a child every 21 seconds. The worst sufferers from bad sanitation are the rural poor and residents of slum areas in fast-growing cities, mostly in Africa and Asia.

Orheruata A.M. (2008) reported that the sudden release of nearly 100 million liters of hog urine and feces polluted neighboring communities and killed millions of fish in nearby rivers. In 2000, drinking water contamination by livestock waste led to several deaths in the Canada town of Walkerton (Catelo et al., 2001). Indiscriminate animal waste disposal on the streets, in drainages, and inside residential houses has a lot of negative impacts on the environment. Some of these impacts include contamination of surface and underground water (rivers, wells, and boreholes). Long animal solid waste deposition in an area has turned many places in the study area into slum areas, thereby attracting flies, cockroaches, and other insects that can easily transfer bacteria, pathogens, and fungi from one place to the other. Daily movement of the animals following the same route for grazing in urban space has accelerated sheet erosion on a flat surface by removing topsoil particles hence destroying the soil aggregate. Movement of the animals on a slop (gentle or moderate) has also promoted gully erosion as some pockets of these features prevail in the study area with its devastating effects on houses, markets, and schools, especially during the rainy season.

It is commonly observed in major farms in Nigeria that animal waste disposal by backyard in commercial piggeries, and poultry farms run into rivers and erosion courses. These contribute a substantial amount to river pollution. Generally, livestock rearing and their wastes have polluted the environment in various ways. These include the chemical and biological impact of manure and urine, physical impact, air pollution, environmental consequences, heavy metal (copper and zinc, which is an essential mineral of livestock diet), land degradation, socio-economic problems, and so on.

Despite its economic contribution to a nation's growth, livestock can cause severe degradation and damage if the livestock and the area are not monitored correctly, as asserted by Hafferman Todd (2000). Similarly, Fabricie cited in Itodo (2001) reported a conflicting urban land uses just as the prey and predator relationship that residential and urban green areas were not designed for the holding and grazing of livestock, and the green areas are often not big enough for the number of livestock grazing on them. This is because overgrazing leads to the disruption and destruction of the natural ecosystem and the degeneration of natural vegetation (Chandre et al., 2008). It is, therefore, clear that if livestock rearing is allowed to be carried out without adopting the principles of checks and balances within the sphere through research, it will subsequently lead to the contamination of both water and land and thereby affecting urban livelihood.

1.1. Problem Statement

Even though urban livestock keeping has significant benefits for the poor and provides a way of diversifying livelihoods that are accessible to vulnerable groups, there are many disease agents that can cause disease in multiple species of animals, including humans. These diseases are called zoonoses. People are exposed to bacteria, protozoa, fungi, viruses, and parasites that cause zoonoses in several ways. Therefore, anyone working with or handling animals' needs to know about zoonoses and the precautions they must take to minimize their risk of infection. Because of the Boko haram invasion in the study area, which has also increased the poverty rate among livestock keepers, most of the livestock owners keep their animals inside their houses in the study area. Other issues that forced the urban livestock keepers to keep their animals inside their houses include the theft of these animals by the youths who have lost their jobs and the inability of the people to increase their residential land. Only a few farm centers are found around, and many of these centers have been abandoned without animals because of the insurgency that persisted over a decade. Therefore, people who have close contact with large numbers of animals, such as abattoir workers, shearers, knackery workers, and veterinarians, are at a higher risk of contracting a zoonotic disease. How does the livestock keeper adjust to the modern urban livestock management and practices adopted in other parts of the globe to have a sustainable and healthy animal and man interface?

Direct interaction between human habitat and that of urban livestock is not clearly specified due to small land holdings by livestock keepers. It is also the main source of solid wastes that are indiscriminately disposed to almost all the streets in Potiskum hence creating slum conditions in many places. Because of its location within the tropics, the study area is susceptible to mosquito-borne diseases. There has also been a worldwide resurgence of vector-borne diseases since the 1970s, including malaria, dengue, yellow fever, louse-borne typhus, plague, leishmaniasis, sleeping sickness, lyme disease, Japanese encephalitis and rift valley fever transmitted through the direct association of man and the livestock. (David M., 2016).

Faeces of livestock has been observed to consist of undigested food, mostly cellulose fibre, undigested protein, excess nitrogen from digested protein, residue from digested fluids, waste mineral matter, worn-out cells from intestinal linings, mucus, bacteria, and foreign matter such as dirt consumed, calcium, magnesium, iron, phosphorus, sodium, etc. Therefore, improper disposal of animal faeces can cause oxygen depletion in the receiving environment. It can also cause nutrient-over enrichment of the receiving system.

Land use planning affecting public wellness, water quality protection, waste management, energy choices, food safety and systems, and ecological protection and restoration are some of the issues that deserve urgent attention. As Lynch *et al*. (2001) point out, perhaps one of the main problems with much research has been that it identifies the advantages of urban livestock rearing from a relatively restricted perspective and fails to engage with its greater understanding in relation to specific issues such as land tenure, health, and environmental concerns.

The study area has already been identified as post insurgent area because after the Boko haram invasion and one of the centers of a number of significant outbreaks in Yobe state due to its contamination of both surface and underground water that has long effects on human health. The quick spread of diseases has been witnessed over the years, and no serious effort has ever been made to understand zoonotic outbreaks emanating from livestock rearing as an attribute. It is usually impossible to determine the degree of exposure of a given individual to a specific problem. Pollutants are numerous and varied, and many of them are difficult to detect. Techniques for monitoring pollutants are inadequate, and long-term records are almost unavailable. Methane is emitted by the digestion of food by animals, for example, cattle, as cited in Tawari C.C. (2012). It is, therefore, pertinent for this research, whose primary focus is to harmonize human health and economic benefits derived from urban livestock. As secondary data, no documents from research bodies, veterinary Doctors, ministry of the environment have been traced in the study area to address the problems. It is these reasons that prompted the research to be carried out in the study area with a view to ameliorating the situation.

1.2. Objective of the Study

The objectives are:

- To assess the rate of pollution occurrence from livestock waste and the nearest water points (wells and boreholes) in the study area
- To test for microbial and physico-chemical characteristics of soil samples.
- To analyze the implication of livestock rearing on the urban environment as it relates to pollution on public health.
- To suggest future research on current knowledge gaps and potential research issues which can be shared with policymakers, farmer's associations, and donors.

2. Research Questions

- What are the problems that livestock keepers face at the planning stage in the urban and peri-urban environment?
- What are the various distances between dumpsites and water points in the study area?

- What is the level of heavy metal concentration and physico-chemical characteristics of soils in the study area?
- What are the effects of direct animal waste disposal on the environment in the study area?
- Are there enough spaces for livestock and the required distance between livestock and human habitat?
- Is there adequate sanitation of livestock premises in the residential plots?

3. Literature Review

3.1. Water Pollution

Soil and water are two essentials that support all forms of plant and animal life and are generally obtained from two principal natural sources:

- Surface water such as freshwater, lakes, rivers, streams, etc., and
- Groundwater, such as borehole water and well water, as contained in Mendie (2005)

On the other hand, soil is an essential component of an ecosystem that derives its source from the disintegration of the parent materials. It contains life on the earth. A community depends on water for its domestic, agricultural, and industrial needs. Water has unique chemical properties due to its polarity and hydrogen bonds which means it is able to dissolve, absorb, adsorb or suspend many different compounds (WHO), 2007); thus, in nature, water is not pure as it acquires contaminants from its surrounding and those arising from humans and animals as well as other biological activities. One of the most important environmental issues today is groundwater contamination. Between the wide diversity of contaminants affecting water resources, heavy metals receive particular concern considering their strong toxicity even at low concentrations (Marcovecchio *et al*., 2007). Galadima et al. (2011) reported that research indicates that most of the common freshwater sources in Nigeria are polluted, resulting in a serious outbreak of these and other diseases. A study by Umeh et al. (2004) showed that 48% of the people in Katsina-Ala Local Government area of Benue state in Nigeria are affected by urinary schistosomiasis due to an increase in water pollution index. Some previous investigations indicate that 19% of the whole Nigerian population is affected, with some communities having up to 50% incidence. This has raised serious concerns to World Health Organization in an attempt to improve the cultural and socio-economic standards of people in the tropical region (Okigbo, 1984; Umeh et al., 2004). Recently, Olaoye and Onilude (2009) also in Galadima (2011) have documented varying levels of microbial contamination in drinking water from western parts of the country. According to these pieces of research, total bacteria and coliform counts were found to be between 2.86 - 4.45 and 1.62 log cfu/ml, respectively. In addition to microbial infections, heavy metal poisoning through drinking water has also been documented. Nriagu et al. (1997) reported blood lead levels greater than 30 μg/dl in children from Kaduna states. The elevated levels were linearly correlated with water and air contaminations by lead emissions. Garba et al. (2010) reported a mean arsenic concentration of 0.34 mg/l in drinking water from hand-dug wells, boreholes, and taps of Karaye Local Government area, Kano state. The arsenic levels are of serious concern to regulatory agencies because they by far exceed the upper band (0.01 mg/l) recommended by World Health Organization (WHO). Heavy metal can cause serious health effects with varied symptoms depending on the nature and quantity of the metal ingested (Adepoju-Bello & Alabi, 2005). They produce their toxicity by forming complexes with proteins in which carboxylic acid (COOH), amine (NH2), and thiol (SH) groups are involved. These modified biological molecules lose their ability to function properly and result in the malfunction or death of the cells. When metals bind to these groups, they inactivate important enzyme systems or affect protein structure, which is linked to the catalytic properties of enzymes.

Although most of the hand-dug wells, as the major source of water in Potiskum, are usually covered, they are not free from contamination from runoff. Pollutants transported by surface runoff are deposited into these wells via available openings and percolation. Cases of water pollution by runoff have been reported by Martin *et al*. (1998). Nitrate remains a major concern in groundwater contamination. Research also indicates that there is a tendency for potential phosphorus to leach into groundwater through sandy soils with high phosphorus content (Citizens Pfiesteria Action Commission, 1997). The presence of nitrates and phosphates in groundwater may increase the microbial load of the water contamination because of its high solubility and health implication. This can be harmful not only to human beings but also to flora and fauna in the study area.

3.2. Dust and Other Particles

Dust has not been reported as an essential environmental issue in the surroundings of farms. Inside the animal house, however, it is known to be a contaminant that can affect both the respiration of the animals and their owners, as cited in Copeland (2006) and Anderson et al. (2003). The highest concentration of airborne dust, bacteria, fungi, and endotoxins can be found within poultry shelters, but high values also occur in swine shelters. Copeland (2006) added that exposures to bioaerosols in animal shelters are associated with a wide range of adverse health effects, including infectious and non-infectious diseases. Endotoxins are particularly harmful since they can induce allergic reactions in the respiratory system that can become chronic.

3.3. Effects of Physico Chemical and Heavy Metal Properties on Human Health

Excess physico-chemical properties in drinking water have different effects on human health. A high value of turbidity causes a bitter taste of water, affects mucous membrane, cause corrosion, and also affects aquatic life (Okpanachi, 2012). A high amount of hardness in drinking water leads to heart disease and kidney stone formation. Excess hardness causes poor lathering with soap, deterioration of the quality of clothes, scale formation, and skin irritation, as confirmed by Okpanachi (2012) in Lalitha and Barani (2004). Excessive chloride concentration increases the rate of corrosion of metals in distribution systems, especially for deep wells. This can lead to increased concentration of metals in the supply, and this can cause laxative effects and gastro-intestinal irritation in humans (WHO, 2002). A high amount of Dissolve Oxygen (DO) imparts a good taste of water. With regards to solids, high values of Total Dissolve Solid (TDS) in groundwater are generally not harmful to human beings. Consumption of water with high Total Solid Substance (TSS) content can cause gastro-intestinal irritation. It also causes undesirable taste and corrosion or incrustation (Shihab, 1993). In terms of heavy metals concentration, high concentrations of heavy metals can cause various health effects in humans. For example, a high intake of chromium can cause skin rashes, upset stomachs, ulcers, respiratory problems, weakened immune systems, kidney and liver damage, alteration of genetic material, lung cancer, and even death (Singh, 2009). Lead is a naturally occurring element that can be harmful to humans when ingested or inhaled, particularly to children under the age of six. Although the effects of lead exposure are a potential concern for all humans, young children (less than seven years old) are mostly at risk (Reagon & Silberged, 1989). In adults, lead poisoning can cause:

- Poor muscle coordination,
- Damage to the sense organs and nerves controlling the body,
- Increased blood pressure,
- Hearing and vision impairment,
- Reproductive problems (e.g., decreased sperm count)

In children, as reported by Assi M.A. (2016), lead can cause damage to the brain and nervous system, behavioral problems, anemia, liver and kidney damage, hearing loss, developmental delays, and in extreme cases, death. Iron and Zinc are essential micronutrients for human health. By micro, it means it is needed only in small quantities (Black, 2003). However, when intake is high and regular, it can cause some health defects, which include liver and kidney diseases, high blood pressure, heart failure, and, in some extreme cases, death (Cardar, 1983).

This type of toxin may also cause the formation of radicals which are dangerous chemicals that cause the oxidation of biological molecules. The most common heavy metals that humans are exposed to are Aluminium, Arsenic, Cadmium, Lead, and Mercury. Aluminium has been associated with Alzheimer's and Parkinson's disease, senility, and prehensile dementia. Arsenic exposure can cause, among other illnesses or symptoms, cancer, abdominal pain, and skin lesions. Cadmium exposure produces kidney damage and hypertension. Musa H.A et al. (1999) reported that access to adequate supplies of good quality drinking water continues to be limited among many rural and peri-urban communities in Africa and many states in Nigeria, despite several decades of water improvement programme.

It is generally conceived that water pollution processes occur in three interlocking ways. These are physical pollution, chemical pollution, and biological pollution. Physical pollution occurs in the deterioration of the physical properties of water, such as colour, turbidity, and suspended particles, as cited in Ahmed (2002).

3.4. Methods and Materials

Pre field exercise known as a reconnaissance survey was carried out for the purpose of identification of location sites. The study used Google Earth imageries to be sourced from Google Earth (digital globes) and a map of Potiskum Township acquired from the headquarter of the local Government. The study also used data in text file format (.txt file) containing the Geographical coordinates, names, and addresses of the identified water points (wells, water pumps, dug boreholes) and animal dung dumpsites. The data regarding the geographical coordinates of the water points and the dumpsites were collected from the study area using a Global Positioning System device (GPS). The data tables were then exported and converted to ESRI (Environmental System Research Institute) Shape file formats using GIS software (ArcMap Version 10.4.2) as it is originally compatible with the software. All of the data layers were incorporated into GIS using ArcGIS Version 10.4 software. All the data were represented using the traditional GIS features classes (Point, Line, and Polygon) as shown in the figure below. All the data were converted and projected to the same coordinate system of UTM Zone 32N Minna Datum except the polygon map of Nigeria and the polygon map of Yobe State that are in ESRI Shapefile indicating the study area. These were geo-referenced in Geographical Coordinates System of World Geodetic Systems of 1984 (WGS 1984). A structured interview using questionnaires was used to collect information on livestock rearing from the sampled population in the study area. Instruments used include: GPS, measuring tape, water/soil containers, bags, etc.

OID	Address	Dumpsites		Water Points		Distance (m)
1	lamba Idris	11.27167N	11.76972E	11.7697222N	11.2716667E	55
2	Jibrin Dallari	11.13028N	011.78028E	11.7802778N	11.1302778E	38
3	Alh. Ishaku J.	11.29056N	011.81278E	11.8127778N	11.2905556E	17
4	Sule Yaroro	11.32528N	011.77972E	11.7797222N	11.3252778E	37
5	Kukar M.	11.14667N	011.83083E	11.8308333N	11.1466667E	38
6	Yindiski G.	11.22889N	011.85667E	11.8566667N	11.2288889E	43
7	New Stadium	11.23278N	011.80944E	11.8094444N	11.2327778E	14
8	Lawan Hosp	11.29167N	011.75306E	11.7530556N	11.2916667E	20
9	Sarkin Baka	11.26306N	011.92472E	11.9247222N	11.2630556E	27
10	Alh. F. Danko	11.34250N	011.80361E	11.8036111N	11.3425E	47

Table 1: Coordinates of Water Points and Dumpsites and the Distance between Them

3.5. Procedure for Data Analysis

The tiles of Google Earth images covering the entire study area were first downloaded from the official website of the digital globe. The Google Earth images were then stitched and geo-referenced using the coordinates of the control points obtained from the original images using GIS software (ArcGIS version 10.4). The Universal Traverse Mercator (UTM) zone 32N Minna Datum was used as a spatial reference system in referencing the data. The final geo-referenced image depicting the study area was then used to create the land use map of the study area. This was done painstakingly by digitizing all the existing land use features such as built-up areas (residential areas), primary and secondary roads, and streams found in the study area. The study area map was also used as a reference while carrying out the digitizing exercises to ensure a reasonable degree of accuracy that reflects reality.

3.6. Database Creation (Data layers)

The following data were/soil collected and used in the development of the GIS data layers.

- The polygon map of the study area.
- Data table containing the geographic coordinates, names, and addresses of the water points.
- The data table containing the coordinates, names, and addresses of the dumpsites.

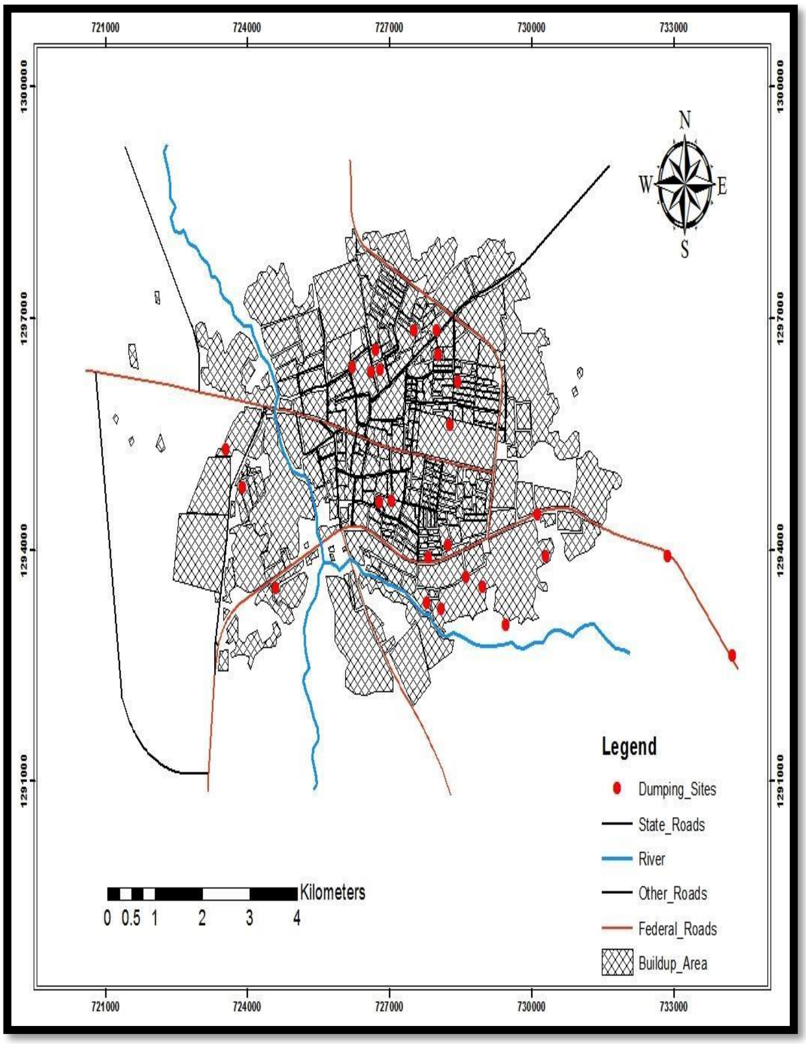

Figure 1: Map of Potiskum Showing Dumping Sites Point Locations
Source: Field Work 2022

3.6.1. Buffer Creation

The impact of the water points contamination was determined using GIS Buffering Operation. GIS Buffering operation could create a radius of a specified distance around a point feature class such as wells or parallel measured distance from linear features such as roads or rivers (Ormsby et al., 2001).

Therefore, the resulting influence from a point, area, or linear items could easily be determined as the concentration area of interest. In this connection, buffers measuring 200 metres Radius were created over the identified water/soil points of the study area to assess the impact of water/soil contamination on the dwellers of the area.

Data obtained were subjected to both descriptive and inferential statistical analysis using tables to arrange and show the distances of wells and boreholes to and from the dumpsites. The results of physico-chemical and heavy metal parameters in water samples from wells and boreholes were compared with the WHO standard limits. The distances between water points and livestock (dumpsites) were used as an experiment between the experimental group and control group, with significance to be declared at 50 meters World Health Organization and Nigeria's standard for the concentration of heavy metals and toxicity level of water.

3.7. Location and Extent of the Study Area

Potiskum town is located roughly between latitudes 11^0 03^1 and 11^0 30^1 North of the Equator and between longitudes 10^0 50^1 and 11^0 15^1 East of the Meridian. Its distance by road from Damaturu (the State capital) is about 98 kilometers west. It is bounded on the north and west by Nangere local government, on the south by Fika local government, and on the east by Fune local government. It covers an area of roughly 120,000 ha or about 12 square kilometers.

3.7.1. Geology

The study area is located at the southwestern margin of the Chad basin. The basin is the largest inland basin, with a surface area of more than 600,000 sq km. Geophysical data indicates its floor to consist of a series of troughs and uplifted blocks. The trough structures correspond to the most northwestern part of the Benue Trough and to its lateral troughs. The Chad formation was deposited over the Kerri-Kerri Formation except along part of the basin margins and at occasional highs in the basin floor, where it directly transgressed the crystalline basement or Cretaceous sediments. The formation corresponds to an almost flat-lying, undisturbed fill of a vast but shallow depression. The Chad basin is bounded to the south by a vast area of the crystalline basement and by limbs of cretaceous sediments of the Benue trough like the continental Bima Formation, the transitional Yolde Formation, and the marine Fika Shale's Formation.

3.7.2. Relief

The landform of the region consists of a gentle, undulating plain with extensive iron pans overlain by Aeolian sands. This region is dotted with isolated residual hills towards the East and South, particularly along Damaturu and Gombe roads. It is a predominantly undulating plain ranging from 457.20 metres with a small narrow valley to a height of 457.32 metres. River Komadugu traverses this valley with the seasonal flow as a result of the construction of dams in the neighbouring states. The effect of such projects has reduced the river to a merely dried valley. The seasonality of the river, steepness as well as the nature of the soil impedes the socio-economic life of the people. To the west is a flat plain that accommodates governmental institutions and ministries and commercial and residential areas. This area is connected to the main town by a bridge constructed across the valley.

3.7.3. Climate

It is generally assumed that a decrease in rainfall implies a decrease in surface runoff and also a decrease in groundwater recharge. In fact, changes in water resources are linked not only with climatic fluctuations but also with environmental changes and human activities.

3.7.4. Temperature

The temperatures are high from (March 39.2^0c to October 37.8^0c) which marks the period of rainy seasons and are low in August to about 29.3^0c. The mean maximum temperature was attained in April and May at 29.2^0c and 37.8^0c, respectively, which also marked the beginning of the rainy season. Temperature is extremely low from November to February, ranging from 20.4^0c to 27.2^0c when the area is under the influence of harmattan, which marks part of the dry season.

3.7.5. Rainfall

The present landscape is inherited from former wetter and drier conditions during the Quaternary (valley cutting, Aeolian ergs, respectively). The study area is, therefore, situated within the tropical savanna (dry and wet) type classified by Koppen as Aw, with rainfall ranging from 750mm-900mm per year. Rainfall in the area starts around late May and stops in October, with the highest amount in August of each year. Runoff from agricultural land and other human activities has been found to increase water pollution indices in Potiskum. Whenever there is rainfall, varieties of contaminants from the atmosphere and land surfaces are deposited into surface and ground waters resulting in pollution.

3.7.6. Wind

The predominant winds are the two trade winds:

- The North-East, and
- The South West

The two trade winds converge in the Inter-Tropical Convergence Zone (ITCZ). The North East Trade Wind operates from November to April, bringing along the harmattan (cold, dry, and dusty) originating from the Sahara Desert. Visibility is highly impaired during this period. From May to September, the South West Trade Winds predominate. This is a moisture-laden air mass that blows northward from the coast and brings rainfall to this region. The seasonal migration of the Inter-Tropical Convergence Zone (ITCZ) from the south to the north and vice-versa determined the season of the study area.

3.7.7. Soil

Soil plays an important role in the development of Yobe state. From whatever dimension one looks at the land, it is on it that all individuals or groups in the community carry out their day-to-day life. Man's life is closely tied to the land and whatever happens to land happens to man (Falola, 2000).

The soil in most parts of the state derived its origin from drift materials which vary in textural characteristics but are mainly silt clay. This profile of soil is poorly developed with a low water retention capacity. Three types of soils can be identified on the basis of their geological formation. These are the dominant leached ferruginous tropical soil, shallow skeleton soils developed over granites, basalt sand storms, and iron stones mostly found at outcrops. Also found are weakly leached ferruginous tropical soils, which consist of sandy, loamy soil with some profile development on sands. It shows slightly alkaline reactions and is acidic with low organic content (Mark Lock Group, 1976). The productivity of soil is greatly impaired due to the lack of adequate vegetation cover to supply organic matter. Wind erosion poses a serious threat to the quality of soil in the active areas of the north. It has been that the windblown fine soil particles have nutrients essential for plant growth. Alluvial soils are also found in the major river valleys, such as the Yobe system, and are suitable for the cultivation of crops like rice and wheat.

3.7.8. Vegetation

Potiskum is within the Sudan vegetation belt. Its regional setting is a specific example of shrubs Savanna and Adasonia parkland. Except for forest reserves that carry acacia, vegetation has been destroyed for fuel wood extraction. Typical trees include: acacia, dump palm, silk cotton, and baobab. The baobab stores water in the trunk like a sponge for the dry season.

It has short and undersized branches shooting out from the head of a fat juicy trunk. The dump palm has tall, straight branches and fan-shaped foliage. The silk cotton tree is the tallest of the group and grows to a height of 9m to 15m. It is from this tree that silk cotton, which serves as raw material in making local mattresses and pillows in the area, is obtained. The vegetation is also exploited for a number of medicinal and other purposes. Most of it is now exploited as firewood and for thatched roofing and mat making. Deforestation has now made the environment vulnerable to desertification. There have been annual migrations of Fulani cattle rearing from south to north over many years. They migrate to the study area during the rainy season, looking for animal feeds, including plants. They usually cut down trees to feed their animals, especially at the beginning of the rainy season and when the dry season is set. Vegetation cover has been affected as a result of this activity, thereby affecting the regeneration of plants and consequently paving the way to wind erosion and desertification. Tree planting campaigns are launched yearly by the state government to replenish the environment.

3.8. Ecological Problems

The increasing incidence of desertification is the most disturbing ecological problem faced in Yobe state. Wind erosion is found to aggravate the problem through the formation of sand dunes in the northern part of the state, especially around Machina, Yunusary, Gaidam, Nguru, and so on. Today the lives of the people around these areas are seriously threatened such that the trend in migration is southward. The poor management of this fragile land through anthropogenic forces (deforestation, overgrazing, bush burning, over-cultivation) has resulted in adverse climatic conditions identified as some of the factors responsible for some of the growing menace of desert encroachment (Wikipedia, 2007).

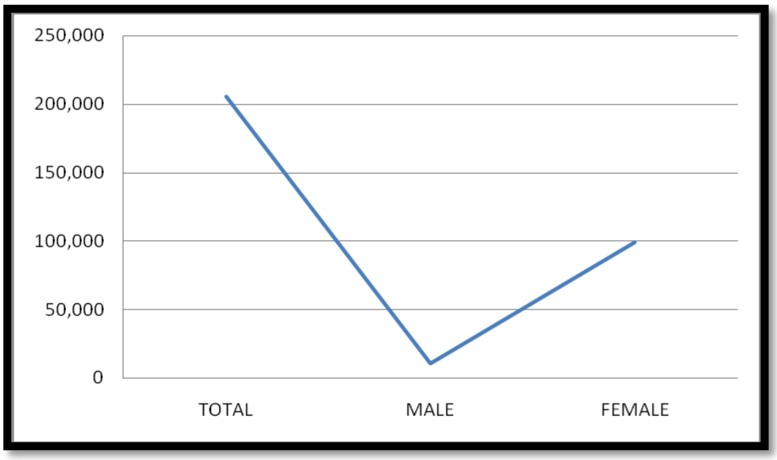

Figure 2: Population Distribution by Gender (2006)
Source: National Population Commission 2006

By estimate, the population of Potiskum was projected to be 332,640 with an annual increase rate of 2.5% and about 39.0% birth rate per 1000 population (National Population Commission 2017). The highest density is recorded within the old settlement around Arikime Ward, with about 9447 persons/km^2. Its major ethnic groups include Ngizim, Bolewa, Karekare, and Fulani. Other minor tribes found in the area include: Ngamo, Hausa, Igbo, and Yoruba.

4. Results Presentation and Discussion

The mean values of Physiocho chemical analysis and heavy metals in ten soil samples can be seen in the table below**.** The data were analyzed in the Department of chemistry analytical laboratory Yobe State University Damaturu, Nigeria.

LAMBA IDRISA (Soil 001)							
			Concentration (mg/Litre)				
	Parameter	**WHO**	**1**	**2**	**3**	**Mean**	**SD**
1	pH	6-8	8.22	8.10	8.22	8.18	0.07
2	Elect Conductivity (uS/cm)	1000	235.00	233.00	235.00	234.33	1.15
3	Nitrate (mg/Litre)	50	6.50	6.54	6.54	6.53	0.02
4	Nitrite (mg/Litre)	0.2	0.22	0.22	0.22	0.22	0.00
5	Sulphate (mg/Litre)	100	15.30	15.50	15.00	15.27	0.25
6	Phosphate (mg/Litre)	5	12.50	12.20	12.50	12.40	0.17
7	Chromium (mg/Litre)	0.05	0.31	0.31	0.31	0.31	0.00
8	Calcium (mg/Litre)	60	19.70	19.75	19.28	19.58	0.26
9	Magnesium (mg/Litre)	0.20	1.21	1.20	1.21	1.21	0.01
10	Lead (mg/Litre)	0.01	0.23	0.22	0.20	0.22	0.02
11	Cadmium(mg/Litre)	0.003	0.32	0.34	0.30	0.32	0.02
12	Iron (mg/Litre)	0.1	2.50	2.21	2.40	2.37	0.15

Table 2

Findings from the laboratory revealed that seven parameters in table 2 at this location (PH- 8-18 phosphate- 12.5, chromium- 0.51, magnesium- 1.21, lead- 0.25, cadmium- 0.52, iron- 2.50) are significantly above the accepted WHO index. This indicates the rate of pollution accelerated by indiscriminate disposal of livestock waste in the study area.

Jibrin Dallari (Soil 002)							
			Concentration (mg/Litre)				
	Parameter	**WHO**	**1**	**2**	**3**	**Mean**	**SD**
1	pH	6-8	8.10	8.00	8.10	8.07	0.06
2	Elect Conductivity (uS/cm)	1000	242.22	243.00	242.80	242.67	0.41
3	Nitrate (mg/Litre)	50	12.56	12.44	12.56	12.52	0.07
4	Nitrite (mg/Litre)	0.2	0.90	0.90	0.90	0.90	0.00
5	Sulphate (mg/Litre)	100	14.23	14.30	14.23	14.25	0.04
6	Phosphate (mg/Litre)	5	1.10	1.02	1.02	1.05	0.05
7	Chromium (mg/Litre)	0.05	1.12	1.13	1.15	1.13	0.02
8	Calcium (mg/Litre)	60	13.11	13.20	13.00	13.10	0.10
9	Magnesium (mg/Litre)	0.20	2.30	2.20	2.20	2.23	0.06
10	Lead (mg/Litre)	0.01	0.02	0.02	0.02	0.02	0.00
11	Cadmium(mg/Litre)	0.003	0.01	0.01	0.01	0.01	0.00
12	Iron (mg/Litre)	0.1	5.50	5.26	5.30	5.35	0.13

Table 3

Table 3 above shows that six parameters are above the acceptable world standard. (PH- 8.7, phosphate- 12.40, chromium- 1.51, magnesium- 2.25, cadmium- 0.01, iron- 5.55). This can be dangerous to both plant and animal health.

Sule Yaroro (Soil 004)							
			Concentration				
	Parameter	**WHO**	**1**	**2**	**3**	**Mean**	**SD**
1	pH	6-8	7.98	7.80	7.98	7.92	0.10
2	Elect Conductivity (uS/cm)	1000	142.80	143.00	142.80	142.87	0.12
3	Nitrate (mg/Litre)	50	1.40	1.40	1.45	1.42	0.03
4	Nitrite (mg/Litre)	0.2	0.14	0.17	0.14	0.15	0.02
5	Sulphate (mg/Litre)	100	1.35	1.22	1.22	1.26	0.08
6	Phosphate (mg/Litre)	5	1.50	1.60	1.50	1.53	0.06
7	Chromium (mg/Litre)	0.05	0.13	0.13	0.13	0.13	0.00
8	Calcium (mg/Litre)	60	18.00	18.50	18.50	18.33	0.29
9	Magnesium (mg/Litre)	0.20	0.54	0.58	0.52	0.55	0.03
10	Lead (mg/Litre)	0.01	0.00	0.00	0.00	0.00	0.00
11	Cadmium(mg/Litre)	0.003	0.02	0.02	0.02	0.02	0.00
12	Iron (mg/Litre)	0.1	0.55	0.54	0.50	0.53	0.03

Table 4

Table 2 at this location shows that only cadmium with a 0.02 value is greater than the acceptable level of WHO. All other parameters fall either below or at the acceptable level.

Kukar Makabarta (Soil 005)							
			Concentration				
	Parameter	WHO	1	2	3	Mean	SD
1	pH	6-8	8.05	8.20	8.20	8.15	0.09
2	Elect Conductivity (uS/cm)	1000	190.20	188.00	187.00	188.40	1.64
3	Nitrate (mg/Litre)	50	1.12	1.15	1.12	1.13	0.02
4	Nitrite (mg/Litre)	0.2	0.02	0.02	0.02	0.02	0.00
5	Sulphate (mg/Litre)	100	2.02	2.02	2.10	2.05	0.05
6	Phosphate (mg/Litre)	5	0.12	0.12	0.12	0.12	0.00
7	Chromium (mg/Litre)	0.05	0.07	0.07	0.07	0.07	0.00
8	Calcium (mg/Litre)	60	15.40	15.10	15.10	15.20	0.17
9	Magnesium (mg/Litre)	0.20	0.34	0.38	0.31	0.34	0.04
10	Lead (mg/Litre)	0.01	0.01	0.01	0.01	0.01	0.00
11	Cadmium(mg/Litre)	0.003	0.03	0.04	0.03	0.03	0.01
12	Iron (mg/Litre)	0.1	0.45	0.51	0.45	0.47	0.03

Table 5

Table 5 revealed that PH (8.15) and cadmium (0.05) values are the two parameters that are above the world standard. All other parameters remain stable below or equal to the international standard.

New Stadium (Soil 007)							
			Concentration				
	Parameter	WHO	1	2	3	Mean	SD
1	pH	6-8	8.00	7.98	7.98	7.99	0.01
2	Elect Conductivity (uS/cm)	1000	210.00	208.50	208.50	209.00	0.87
3	Nitrate (mg/Litre)	50	2.30	2.20	2.20	2.23	0.06
4	Nitrite (mg/Litre)	0.2	0.20	0.20	0.25	0.22	0.03
5	Sulphate (mg/Litre)	100	2.80	2.72	2.80	2.77	0.05
6	Phosphate (mg/Litre)	5	1.31	1.23	1.23	1.26	0.05
7	Chromium (mg/Litre)	0.05	0.12	0.12	0.14	0.13	0.01
8	Calcium (mg/Litre)	60	3.33	3.21	3.21	3.25	0.07
9	Magnesium (mg/Litre)	0.20	0.15	0.17	0.15	0.16	0.01
10	Lead (mg/Litre)	0.01	0.13	0.12	0.13	0.13	0.01
11	Cadmium(mg/Litre)	0.003	0.07	0.07	0.07	0.07	0.00
12	Iron (mg/Litre)	0.1	1.05	1.12	1.05	1.07	0.04

Table 6

The following parameters (Chromium- 0.18, lead- 0.15, cadmium- 0.05) appeared to be above the world standard at this location, which can be compared and seen from the table. Nine parameters are, therefore, either below or at the WHO levels.

Asibitin Musa Lawan (Soil 008)							
			Concentration				
	Parameter	WHO	1	2	3	Mean	SD
1	pH	6-8	7.88	7.90	7.78	7.85	0.06
2	Elect Conductivity (uS/cm)	1000	152.30	151.50	151.50	151.77	0.46
3	Nitrate (mg/Litre)	50	3.02	3.12	3.02	3.05	0.06
4	Nitrite (mg/Litre)	0.2	0.21	0.21	0.31	0.24	0.06
5	Sulphate (mg/Litre)	100	0.04	0.04	0.04	0.04	0.00
6	Phosphate (mg/Litre)	5	1.88	1.79	1.84	1.84	0.05
7	Chromium (mg/Litre)	0.05	2.07	2.04	2.10	2.07	0.03
8	Calcium (mg/Litre)	60	2.11	2.01	2.01	2.04	0.06
9	Magnesium (mg/Litre)	0.20	0.11	0.12	0.11	0.11	0.01
10	Lead (mg/Litre)	0.01	2.20	2.41	2.35	2.32	0.11
11	Cadmium(mg/Litre)	0.003	0.02	0.02	0.02	0.02	0.00
12	Iron (mg/Litre)	0.1	3.22	3.31	3.22	3.25	0.05

Table 7

Table 6 reported four parameters from the laboratory to be greater than the world standard. These include: Chromium (2.07), lead (2.52), cadmium (0.02), and iron (5.52), respectively.

Sarkin Baka (Soil 009)							
			Concentration				
	Parameter	**WHO**	**1**	**2**	**3**	**Mean**	**SD**
1	pH	6-8	8.45	8.30	8.30	8.35	0.09
2	Elect Conductivity (uS/cm)	1000	205.00	200.00	207.00	204.00	3.61
3	Nitrate (mg/Litre)	50	12.20	12.50	12.50	12.40	0.17
4	Nitrite (mg/Litre)	0.2	0.02	0.02	0.02	0.02	0.00
5	Sulphate (mg/Litre)	100	1.50	1.25	1.40	1.38	0.13
6	Phosphate (mg/Litre)	5	1.20	1.00	1.00	1.07	0.12
7	Chromium (mg/Litre)	0.05	0.14	0.15	0.14	0.14	0.01
8	Calcium (mg/Litre)	60	4.50	4.80	4.20	4.50	0.30
9	Magnesium (mg/Litre)	0.20	1.21	1.20	1.00	1.14	0.12
10	Lead (mg/Litre)	0.01	0.02	0.02	0.02	0.02	0.00
11	Cadmium(mg/Litre)	0.003	0.00	0.00	0.00	0.00	0.00
12	Iron (mg/Litre)	0.1	1.33	1.28	1.28	1.30	0.03

Table 8

PH (8.55), chromium (0.14), magnesium (1.14), and iron (1.50) values are the four parameters reported to be above the acceptable world level. Their concentration in the water samples may be a hazard to both human and animal life.

Alhaji Ibrahim Furan Danko (Soil 010)							
			Concentration (mg/Litre)				
	Parameter	WHO	1	2	3	Mean	SD
1	pH	6-8	8.20	8.00	7.90	8.03	0.15
2	Elect Conductivity (uS/cm)	1000	126.20	125.00	125.00	125.40	0.69
3	Nitrate (mg/Litre)	50	1.20	1.20	1.28	1.23	0.05
4	Nitrite (mg/Litre)	0.2	0.00	0.00	0.00	0.00	0.00
5	Sulphate (mg/Litre)	100	1.60	1.50	1.50	1.53	0.06
6	Phosphate (mg/Litre)	5	0.20	0.28	0.20	0.23	0.05
7	Chromium (mg/Litre)	0.05	3.20	3.00	2.80	3.00	0.20
8	Calcium (mg/Litre)	60	1.54	1.58	1.50	1.54	0.04
9	Magnesium (mg/Litre)	0.20	0.40	0.48	0.40	0.43	0.05
10	Lead (mg/Litre)	0.01	0.01	0.01	0.01	0.01	0.00
11	Cadmium(mg/Litre)	0.003	0.00	0.00	0.00	0.00	0.00
12	Iron (mg/Litre)	0.1	2.75	2.50	2.50	2.58	0.14

Table 9

At this location, only iron with a high value of 2.58 was found to be significantly above the standard level. All other parameters remain stable either below or at the acceptable level.

Muazu (Soil)							
			Concentration				
	Parameter	**WHO**	**1**	**2**	**3**	**Mean**	**SD**
1	pH	6-8	7.91	7.80	7.80	7.84	0.06
2	Elect Conductivity (uS/cm)	1000	150.00	155.00	150.00	151.67	2.89
3	Nitrate (mg/Litre)	50	1.97	1.88	1.97	1.94	0.05
4	Nitrite (mg/Litre)	0.2	0.20	0.28	0.20	0.23	0.05
5	Sulphate (mg/Litre)	100	0.88	0.80	0.80	0.83	0.05
6	Phosphate (mg/Litre)	5	1.19	1.10	1.10	1.13	0.05
7	Chromium (mg/Litre)	0.05	0.23	0.30	0.23	0.25	0.04
8	Calcium (mg/Litre)	60	1.20	1.29	1.23	1.24	0.05
9	Magnesium (mg/Litre)	0.20	0.51	0.45	0.45	0.47	0.03
10	Lead (mg/Litre)	0.01	0.35	0.23	0.23	0.27	0.07
11	Cadmium(mg/Litre)	0.003	0.10	0.08	0.08	0.09	0.01
12	Iron (mg/Litre)	0.1	1.18	1.12	1.20	1.17	0.04

Table 10

PH value of 8.09, Chromium value of 0.25, lead value of 0.27, and cadmium value of 0.09 are all reported to be greater than the World Health Organization (WHO) acceptable values. Eight parameters from the research revealed that they are at an acceptable level.

Alhaji Umaru Jigawa K (Soil 014)							
			Concentration				
	Parameter	WHO	1	2	3	Mean	SD
1	pH	6-8	8.16	8.10	8.00	8.09	0.08
2	Elect Conductivity (uS/cm)	1000	89.50	88.20	88.00	88.57	0.81
3	Nitrate (mg/Litre)	50	0.99	1.02	0.99	1.00	0.02
4	Nitrite (mg/Litre)	0.2	0.05	0.02	0.01	0.03	0.02
5	Sulphate (mg/Litre)	100	0.30	0.24	0.24	0.26	0.03
6	Phosphate (mg/Litre)	5	0.06	0.10	0.06	0.07	0.02
7	Chromium (mg/Litre)	0.05	1.04	1.10	0.98	1.04	0.06
8	Calcium (mg/Litre)	60	1.04	1.51	1.04	1.20	0.27
9	Magnesium (mg/Litre)	0.20	0.22	0.22	0.30	0.25	0.05
10	Lead (mg/Litre)	0.01	0.00	0.00	0.00	0.00	0.00
11	Cadmium(mg/Litre)	0.003	0.00	0.00	0.00	0.00	0.00
12	Iron (mg/Litre)	0.1	0.15	0.15	0.14	0.15	0.00

Table 11

Table 10 above shows that only PH with a value of 8.09 is slightly above the international value.

Table 12 shows acceptable Chemical Parameters units (soil sampled) and that of the laboratory and their respective implications.

Parameters	Unit	WHO	Lab.	Health impact
Cadmium	mg/L	0.003	0.84	cancer, abdominal pain, and skin lesions
Lead	mg/L	0.01	2.20	increased blood pressure, hearing and vision impairment,
Nitrate (NO3)	-	50	37.50	-
Nitrite (NO2)	-	0.2	2.80	-
Sulphate (SO4)	-	100	15.30	-
Total Dissolved Solids	TDS	500	324.00	Gastro-intestinal irritation.
Parameters	Unit	WHO	Lab.	Health impact
Magnesium (Mg+2)	-	0.20	2.30	-
Chromium (Cr6+)	-	0.05	3.30	skin rashes, upset stomachs, and ulcers
PH		6.5 - 8.8	7.22-8.22	affects mucous membrane
Copper		1	2.88	lung tissue bloodstream disease
Calcium	mg/L	60 (soft)	19.70	
Iron (Fe+2)		0.1	5.88	liver and kidney diseases, high blood pressures

Table 12

Source: Research work 2022 Department of chemistry analytical laboratory Yobe State University Damaturu Nigeria

Table 12 above shows the concentration of heavy metals in the soil sample and the acceptable level of World Health Organization (WHO). Nitrate (37.50), Sulphate (15.30), and Calcium (19.70) are below the maximum level. Others are above the acceptable level, including Cadmium (0.84), Lead (2.20), Nitrite (2.80), Magnesium (2.30), Chromium, (3.30), Copper (2.88), Iron (5.88). This indicates that most of the chemicals variables have a high level of concentration in the soil sample isolation and characterization of Coliform bacteria on EMB and Lactose Agar.

Samples	Appearance on EMB	Appearance on L.A
W1	Pink, mucoid, and opaque with a smooth surface	Mucoid, creamy, opaque, and yellowish with rough surface.
W2	Greenish metallic sheen, opaque and smooth surface	Pink, creamy, opaque, and yellowish with rough surface
B3	Not Detected	Not Detected
W4	Pink, mucoid, and opaque with a smooth surface	Mucoid, creamy, opaque, and yellowish with rough surface.
W5	Pink, mucoid, and opaque with a smooth surface	Mucoid, creamy, opaque, and yellowish with rough surface.
W6	Not Detected	Not Detected
W7	Greenish metallic sheen, opaque and smooth surface	Pink, creamy, opaque, and yellowish with rough surface
W8	Greenish metallic sheen, opaque and smooth surface	Pink, creamy, opaque, and yellowish with rough surface
W9	Pink, mucoid, and opaque with a smooth surface	Mucoid, creamy, opaque, and yellowish with rough surface.
W10	Greenish metallic sheen, opaque and smooth surface	Pink, creamy, opaque, and yellowish with rough surface

Table 13: Showing Microbial Analysis of Water Samples

W = Hand dug well

B = borehole

On microbial analysis, 10 water points were tasted, revealing the toxic level of both Eosin Methylene Blue (EMB) and Lactose Agar (LA). The appearance of the water sample with the following characteristics (Greenish metallic sheen, opaque and smooth surface) on EMB and (Pink, creamy, opaque, and yellowish with rough surface) on Lactose Agar indicate that the water sample is highly toxic. While Pink, mucoid, and opaque with a smooth surface on EMB and Mucoid, creamy, opaque, and yellowish with rough surface on Lactose Agar indicates that the water is less toxic. From the table above, it is clearly noted that water in the study area contains toxic substances due to livestock rearing in the study area.

4.1. The Effects of Urban Livestock Movement on the Environment

The effects of livestock rearing on the environment are determined largely by the movement of the animals (roaming or restricted) and the place of animals' waste disposal.

Waste Disposal	Number	%
Inside the house	41	21
On the street	107	55
Inside bags	17	9
Inside the drainage	28	14
Others	2	1
Total	195	100

Table 14: Place of Livestock Waste Disposal
Source: Fieldwork 2022

The solid waste generated from urban livestock is usually disposed of on the available spaces inside the house in bags, on the street, and inside drainage, as can be depicted in table 13 above. The majority of the respondent's views (55%) show that livestock waste has been disposed of on the street, which usually blocks waterways during the rainy season, which has a deteriorating effect on the environment. The effects of this are not limited to the environment in terms of the collapse of buildings, contamination of water, and eyesore, among others, as this also affects the people in terms of the breakout of diseases.

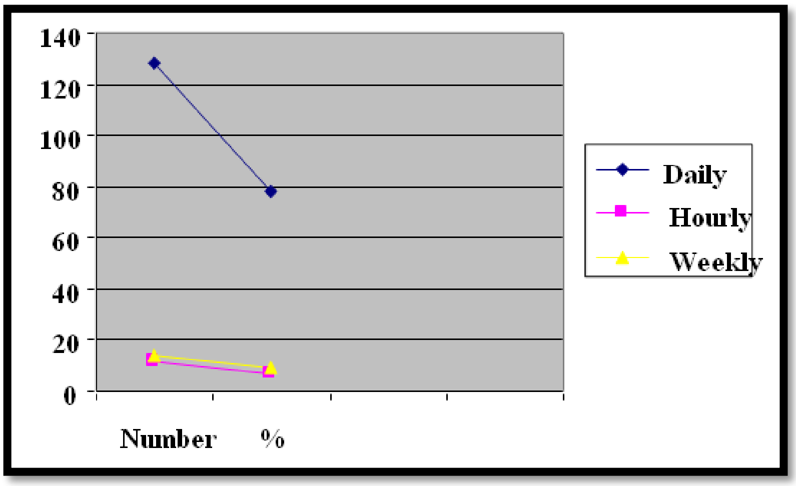

Figure 3: Showing Adequacy of Period of Sanitation of Livestock Premises
Source: Field Work 2022

From the graph above, the result shows that there are inadequacies in the period of sanitation of livestock premises. According to these results, more than half of the respondents were of the view that the premises of their animals are maintained only once a day, while it is a known fact that animals, just like humans, can urinate and drop its dungs at least 3 times per day when properly fed. The results further indicate that 79 percent clean their animal premises on daily bases, while 11 percent and 12 percent of the respondents have the premises of the animals cleaned on a weekly and hourly basis. Therefore, it is beyond any reasonable doubt that all the effects of livestock waste reported in the tables proved to be true.

4.2. Size of Plots Owned by Urban Livestock Keepers

The size of the building where urban livestock can be raised has to go in conformity with the planning laws. It stipulates that a minimum plot size of 30/15-meter, equivalent to (100/50ft) plot, is recommended for urban livestock production for the health and betterment of both the animals and their owners. The adoption and implementation of this policy have gone a long way in preventing and controlling quick zoonotic transmission among livestock keepers in the developed world.

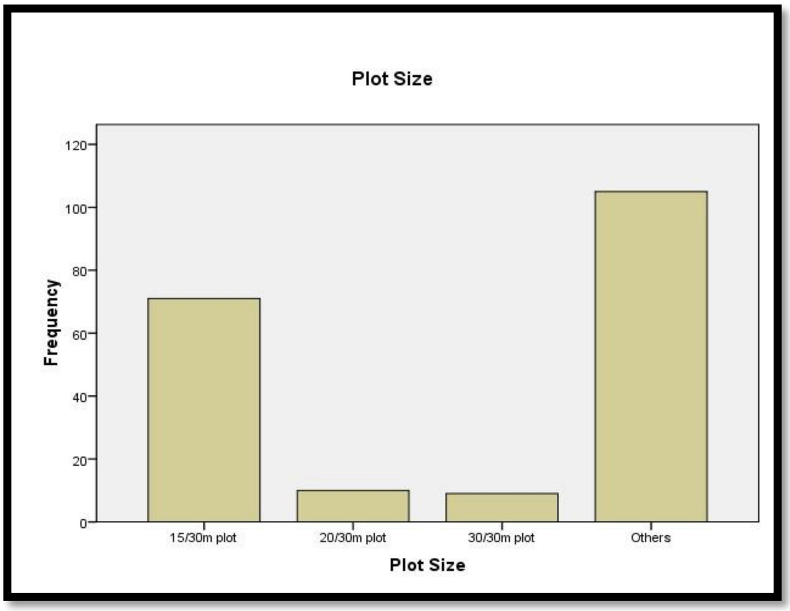

Figure 4: Bar Graph Showing Sizes of Plots Owned by Livestock Keepers

The sizes of the residential houses of the respondents are also a great concern in the study area. From the graph above, it can be seen that the sizes of the houses of 60 respondents are smaller than the required plot size of 15/30 meters. While 120 respondents are under the category of others in the bar graph usually owned a half plot, a quarter plot, or even less than that. This indicates that there is a close association between animals and humans in such habitats; therefore, zoonotic diseases can easily be transmitted to humans. Nowadays, livestock-associated infectious diseases are still a major threat to human health. Only a few livestock keepers (20) have enough space to raise animals in their houses, as can be seen that plot sizes of 20/30 and 30/30 have short bars on the frequency array. Many livestock keepers reside together with their animals in small size houses in the study area because of three major reasons:

- The rapid growth of population in the study area,
- The land tenure system,
- Level of education

4.3. Suggestions Given by the Respondents on Urban Livestock Rearing

Suggestions were raised by most of the respondents with the hope that individuals, groups, philanthropists, governments, and non-governmental organizations (NGOs) would come to their rescue and offer them all the desired support to alleviate their problems.

- 22 percent of the respondents were seeking government assistance,
- 19 percent were desperately seeking adequate access to veterinary services,
- 8 percent were looking for a soft loan to increase their business,
- 8 percent were in support of the creation of more space in order for them to increase the sizes of their land holdings to meet up the planning guidelines

Some of the livestock owners seek government jobs, particularly the educated ones. Relocation and allocation of full plot size and so on are the majority, with 41 percent. This will involve the intervention of planning laws, environmental laws, the Land Use Act, etc., for assistance and support to the urban livestock keepers.

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