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FOREWORD

Close involvement with society is the destiny of science. Like the arts, the environment serves as a basis for cultural identity and a fount for social welfare. As in the natural sciences, students set out to reach a better understanding of vital natural assets. The tools of environmental and resource management provide guidance as we weigh development against nature, present against future, and certainty against the unknown. In the last four decades, there has been an increased awareness of a wide range of environmental issues covering all sources: air, land, and water. More and more people are becoming aware of these environmental concerns, and it is important that professional people, many of whom do not possess an understanding of environmental problems, have the proper information available when involved with environmental issues. All professionals should have a basic understanding of the technical and scientific terms related to these issues as well as the regulations involved.

Urbanization and industrialization have not, however, been an unmixed blessing because these successes have come at a high environmental cost. The detrimental effects of this development include water, air, and soil pollution, as well as the loss of wildlife, habitats, and landscape features. As environmental sustainability entails maintaining productivity while protecting the natural resource base, there is increasing general recognition of the need to improve environmental performance, by enhancing the benefits and reducing the harmful environmental effects. Hopefully, this book will serve the needs of the scientist and students of tertiary institutions by increasing their knowledge and awareness of and helping solve the environmental problems that society is facing now.

The book is primarily intended for both undergraduate and postgraduate students of environmental and resources management as well as those in geography and other physical sciences who may have limited environmental Knowledge. It is presented in simple, understandable terms for students, practicing scholars and scientists, and even the general public who need to know the fundamentals of the many environmental issues that exist and will continue to exist in the future. The authors' objective is also to provide background material on numerous environmental issues and information on what each individual can do to help alleviate some of these problems.

The purpose of the textbook is to cover the most enriching topics in the field with a rigorous yet accessible approach. Thismaiden edition of a stand-alone twenty-chapter book, is arranged along the major environmental fields. It is rich with contemporary issues related to the environment and the latest developments in the field that addresses the critical objectives of environmental management literacy with policy-oriented, application-based content delivered in a clear and concise manner. In terms of pedagogy, this book teaches with images, numerical examples, and data from empirical studies. "Reality checks" in each chapter delve more deeply into the application of environmental management principles in the real world. The book, therefore, holds added allure because it speaks directly on practices and policy decisions that will determine our fate. Thus, the maiden edition proved to be a very timely action and a good step in the right direction.

The book 'Contemporary Issues Environmental and Resource Management' presents a range of case studies that demonstrate the complementary application of different social science techniques in combination with ecology-based management thinking to the natural environment. The selection of diverse issues in different chapters of this book is in line

with the widespread realization that environmental knowledge, science, and technology can be used to reduce environmental degradation and facilitate equitable environmentally, socially, and economically sustainable development.

With contributions from leading authorities in the field, this innovative book provides a valuable teaching aid for students, as well as an insightful and practical reference tool for environmental practitioners with no background in the social sciences. Environmental managers and policymakers attempting to learn about, and integrate thinking from, the contemporary issues related to environmental management should also not be without this important resource.Every chapter abounds with the enthusiasm of the authors, who convey the intellectual fascination of environmental management, its profundity, and its breadth, as well as open a valuable window of information regarding resources management. This eloquent and unique Handbook provides a broad overview, complemented by specific case studies and techniques that are used in environmental management at all levels.Bringing together a wealth of knowledge, the bookgives a comprehensive overview of environmental problems, their sources, their assessment, and their solutions. Through in-depth entries and a topical table of contents, readers will quickly find answers to questions about issueson the environment.

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Environmental Impact of Urban Poultry Farms in Kuje, Suburbia, Abuja

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Abstract
Urbanization is related with unemployment and food security issues in cities. Poultry farming is an important strategy to supplying urban inhabitants with the protein they need. However, the residents' perceptions and acceptance of urban farms are changingdue to negative externalities with adverse effect to the environment and huma health. This study investigates the environmental effects of urban poultry farms in Kuje suburbia Abuja.Samples of water, soil and air were taken and physico-chemical parameters were measured. The results showed concentrations of some heavy metals and particulate pollutants that exceeded permissible limits, and therefore, pose environmental concern. The study recommends among others the need for appropriate re-enforcement regulatory measures that speculate timely environmental auditing by concerned authority to mitigate the adverse effects of material pollutants on the environmental and risk of health hazards on the residents.

Keywords: Urban agriculture, Community health, Environmental Pollution, Environmental Audit

1.0 introduction

At the moment, nearly three billion people live in urban areas globally, accounting for 55 percent of the world's population, with 68 percent expected to do so by 2050 (United Nations, 2018).With urbanization on the rise, one answer to this problem is the extension and development of urban agriculture. The increasing rate of urbanisation is related with unemployment and urban food security issues. Residents have embraced the concept of urban agriculture, which involves the cultivation of animals and crops in urban and peri-urban settings, to address food security concerns in cities (Tornaghi, 2014).

Food produced in urban and peri-urban areas has a variety of ramifications. For example, the viability of small- to medium-sized farmers might be dependent on providing local items that can be (exclusively) marketed through direct channels, such as farmers markets. Urban agriculture has an impact on social health as well. However, urban agriculture can

have negative externalities (Wortman & Lovell, 2013). For example, a farmer growing food in a city may face opposition from residents who are upset by filth and noise from machinery, odours from organic fertilizers, or are concerned that pesticides and fertilizers are polluting the air and the water they drink. Wielemaker*et al.* (2019), discovered that urban farmers use fertilizer in excess of crop demands by 450-600 percent, potentially contributing to poor public opinions. Urban farms may be preferred by residents because they provide access to fresh, local, nutrient-dense food. However, the residents' perceptions and acceptance of urban farms are changing. This is critical to the success of urban agriculture (Grebitus et al., 2020).

Poultry farming is one of the major urban agricultural practices in Nigeria. It is a vital approach toward providing urban residents with the required protein intake in form of eggs and meat(United States Department of Agriculture (USDA,2018). Poultry industry globally has made tremendous changes to meet the increasing demand for inexpensive and safe supply of meat and egg (FAO, 2018). This increasing demand has been accompanied by structural changes within the sector characterised by the emergence and growth in commercial and industrial farming establishments as well as the intensification of poultry operations (Shashank, 2013).

According to the World Economic Forum (2019), it is anticipated that by 2030, demand for chicken products on the African continent would rise by 60%, particularly in Nigeria, the continent's largest market. Presently, the continent's consumption of chicken meat and egg products is about 100 million tonnes, with Nigeria consuming 192.69 MT per year (Abioye, &Abadunmi,2022; Ritchie and Roser, 2020). Poultry farming is capable of addressing the four core dimensions of food security - food availability, food access, food utilisation and food stability (Sassi, 2018). In Nigeria, the poultry industry has been the most demanding in terms of agricultural goods, with considerable potential for long-term growth through youth empowerment programs (Ajani, Mgnbenka, and Onah, 2015; Price, 2019). However, poultry farming has been associated with a plethora of health and environmental impacts (Foeken, 2006).

The effects of poultry farms have been studied from various perspectives. Delgado *et al.*, (2016) in their research indicated that the growth in meat consumption worldwide, has led to an increase of waste by livestock systems that pose dangers to the environment. Kalhor *et al.* (2016), specifically focused their studies on airborne pollutants, poultry production releases significant emissions of ammonia (NH_3), methane, and sulphur dioxide.Li*et al.*, (2018) posited that between 30 and 90% of the antibiotics administered to livestock are excreted non-metabolized into the environment through manure. Xie*et al.*, (2018a), also confirmed that contamination of antibiotics in the environment by anthropogenic activities increases the competitive advantage of antibiotic resistant bacteria by gradually reshaping the resistant in the environment. Chicken droppings generally contaminate the litter spread in poultry houses and poses great environmental threats during the process of disposing the litter (Alabi *et al.* (2014). This is because improper disposal leads to air pollution from unpleasant odours, breeding of flies, and water pollution.Livestock farming systems are major source of trace gases contributing to atmospheric pollution locally and globally (Appuhamy*et al.*, 2016). The greenhouse gas emissions of livestock production and its by-products accounted for 18% of global total emissions (IPCC, 2014; Adeoye *et al.*, 2014).

A large number of studies have been conducted investigating various aspects of the environmental pollution and human health impacts of poultry farms, however, these

studies generally ignore external influences such asenvironmental pollutionand the potential human health risks from exposures. Moreover, transboundary emerging and re-emerging infectious diseases are increasingly being recognized as interrelated risks to human health, livestock, and animal communities (Miller *et al.*,2017), especially, with the fear posed by Covid-19 pandemic and the current cases of monkey pox. Thus, comprehensive review of activities of urban poultry farms and the effect on environmental and public health explains the importance of this study. The study would investigate the poultry farms and identify major impacts on the environment, and provide the potential health risk factors. This paper therefore, prove indispensable to urban policy makers, planners, health and environmental organizations on environmental impacts of poultry farms.

2.0 Literature Review

2.1 Urban Sustainability: Environmental and Health Implications of Poultry Farming

Cities are considered as complex adaptive socio-biophysical systems (Childers et al., 2014). James et al., (2015) noted that cities are currently the habitat and 'zone of survival' of humanity in the 21st century. They identified the need to shift emphasis from the growth-based narrative to a more holistic consideration of cities as ecological systems whose alterations are capable of threatening human existence. Childers et al. (2014) observed that the urban sustainability is a result-based and solution-oriented theory that considers humans as 'ecological stewards'. In other word, urban sustainability is concerned with the development and consumption of healthy and liveable cities (Steiner 2011, 2014; Wolch*et al.* 2014). As James et al. (2015) argued, "Cities are at the heart of the problems facing this planet, but developing a positive and sustainable mode of urban living is the only way that we will be able to sustain social life as we know it past the end of this century".

Rapid development of urban agriculture is associated with greenhouse gases (GHGs) and ammonia (NH3) emissions and climate change contributing to atmospheric pollution locally and globally (Piha et al., 2007; Broto and Bulkeley, 2013). Livestock farming systems are major source of trace gases contributing to atmospheric pollution locally and globally (IPCC ,2014; Appuhamy et al., 2016; van der Weele et al., 2019). The greenhouse gas emissions of livestock production and its by-products accounted for 18% of global total emissions, suspended solids, nutrients, metals and pharmaceutical compounds (Pimentel et al., 2005; Rodić et al., 2011; Sabiha et al., 2016). Application of Livestock manure has the consequence of nutrients and antibiotics which seep from soils into ground and surface waters, having a devastating effect on water quality, favouring the growth of algae, accelerating eutrophication and promoting the spread of antibiotic resistant bacteria (Hooda *et al.*, 2000; Martinez, 2009; Girard *et al.*, 2014; Sabiha et al., 2016; Almeida *et al.*, 2017).

The presence of poultry manure in poultry farm operations has been identified as a significant source of pollution, leading to a decrease in oxygen levels and subsequent mortality of aquatic organisms. The disproportionate discharge of nitrogen, phosphorus, zinc, and copper through poultry excreta is attributed to the surplus provision of protein and phosphorus, coupled with insufficient utilisation of vital trace elements (Taiwo &Arowolo, 2017). The gaseous form of ammonia is known to cause irritation in the nasal

and respiratory systems, while the nitrates present in fertilisers and manure have the potential to seep into groundwater and pose a risk to human health (Gržinić et al.,2022).

3.0 Methodology

3.1 The study Area

The study was conducted within the geographical boundary of Kuje Area Council. ChukukuKiyi and Chibiri of Kujesuburban.TheKuje Area Council covers a total land of about 1,800 square kilometres about 22.5% of the FCT (Ojigi*et.al*, 2012). It has an estimated population of about 270,000 people comprising Gbagyi, Gude, Bassa and Fulani with other ethnic group that have migrated from other parts of Nigeria and the world at large (Ojigi*et.al*, 2012).Kuje Area Council is bounded on the West of Gwagwalada Area Council, North and East of Abuja Municipal Area Council and the South of Abaji Area Council.

3.2 Methods

Experimental Sampling Procedure and Analysis

The study sampling technique comprises of two-stage procedure. The first stage involved the random selection of poultry farms in the study area based on scale of operation (large scale) and production while the second stage involved a purposive selection of the nearest residents within a distance of 500 metres to the sampled poultry farms.

Water samples for physical and chemical properties were collected with clean pre-washed three (3) litre bottles for surface water, borehole and well water using hand sampling method. The Soil Sample taken from the site in four (4) plastic leather at an interval of 20 meters, 40 meter, 60 meters and 200 meters and labelled Soil A, Soil B, Soil C and Soil D. The Physico-chemical parameters of the water and soil were tested employing standard methods in the Central Services Laboratory of the Department of Water Resource and Soil Sciences Federal University of Technology Minna, Niger.The laboratory results were compared to the Federal Ministry of Environment regulatory standard guidelines.

Additionally, the ambient air quality measure was conducted at the farm site using PCE-RCM 0.5 air quality meter to measure the sampling volume of air for chemical analysis. The concentrations of contaminants in the atmosphere may vary significantly from time-to-time due wind speed and direction. The air quality measure results were compared to the Federal Ministry of Environment regulatory standard guidelines. The parameters measured include Sulphur Dioxide (SO_2), Suspended Particulate Matter (SPM) and Carbon Monoxide (CO2).

4.0 Result and Discussion

4.1 *Impact of poultry farm on surface water, soil and air Quality*

The impact of poultry farms on surface water, soil and air quality in Kuje suburbia were assessed and the effect determined based on the World Health Organization (WHO, 2011), National Environmental Standard and Regulation Enforcement Agency (NESREA, 2011) and Federal Ministry of Environment (FMENV, 2008)regulatory guidelines.

4.1.1 Impact on Water Quality

The result of the sample test analysis of surface water, borehole water, and well water is presented in Table 1. The analysis results reveal the presence of concentration of some chemicals above the WHO/NESREA guidelines, suggests that the poultry activities pose some environmental concern in the Kuje suburbia. The laboratory test results reveal the presence of concentration of Total Dissolve Solidsin surface water(82mg/l), borehole water(169mg/l), and well water(45mg/l) above the benchmark of <5.5mg/l, Manganese–(surface water 7.12mg/l);(borehole water, 6.64mg/l), and well water(6.80mg/l) above the benchmark of 0.5mg/l.Also, the presence of Phosphate, Nitrate and Biochemical Oxygen Demand (BOD) in the water sample are significant and above the required standard.

The extent of water contamination resulting from organic matter present in non-settling suspended and colloidal particles was measured by the amount of oxygen consumed by aerobic bacteria during the biochemical oxidation of said substances in a one-liter sample (Zhang *et al.*, 2020). The high biochemical oxygen demand (BOD) exhibited is an indication that the effluent waters of poultry farms have significant organic pollutant presence in waste above the maximum permissible concentration of 5 mg/l (Akpoveta et al., 2011). This study finding corroborates with previous studies (Abioye and Abadunmi, 2022; Ajala&Famuwagun, 2020) that found that poultry farm activities produce materials such as manure that pollute surrounding water by runoff, leaching, and atmospheric deposition. Poultry manure is a major pollutant associated with poultry farm operations, reducing oxygen levels in water. Excessive emissions of nitrogen, phosphorus, zinc, and copper via poultry wastes result from excess supplies of protein and phosphorus as well as inadequate use of essential trace elements. Excess nitrogen can induce eutrophication of surface water resources, and nitrate (>10 ppm or 0.20.2 mg/l) in drinking water causes blue baby syndrome in babies (Ogejo, 2010). Akpoveta et al. (2011) found that both wells and borehole water are less contaminated when they are located far away from any potential sources of pollution and when they are constructed with good well design and disinfection.

Table 1: Results of the Physico-chemical Parameters in Water Sample around the farms

Parameters	Mean Sample score				WHO/NESREA guidelines
	Stream water	Borehole water	Well water		
LAT: 299850°E	LAT: 299930°E LOG: 984437°N		LAT: 299875° E LOG: 9840110° N	LOG:984320°N	
pH6.736.826.76		6.5-8.5			
Conductivity	148uSiemen	304uSiemen	388uSiemen		1000uSiemen
Total Hardness (TH)	50 mg/l	65mg/1	70mg/1		50 -200mg/1
Total Dissolve Solids	**82mg/1**	**169mg/l**	**45mg/1**		<5.5mg/1
Calcium	21.09mg/l	37.82mg/1	42.1mg/		75mg/1
Manganese	**7.12mg/l**	**6.64mg/l**	**6.80mg/1**		0.05-0.5mg/1
Sodium	2.83mg/l	5.96mg/1	3.54mg/1		200mg/ 1
Potassium	0.66	1.44mg/1	0.78mg/1		200mg/1
Phosphate	**0.13mg/1**	**2.24mg/1**	**1.94mg/1**		0.5mg/1
Nitrate	**2.19mg/1**	**3.44mg/1**	**5.6mg/1**		0.2mg/1
BOD	**6.76mg/1**	3.50mg/1	**8.27mg/1**		5mg/1
COD	9.23mg/1	16.65mg/1	16.65mg/ **1**		80mg/1

Source: Authors Field Survey,2020.

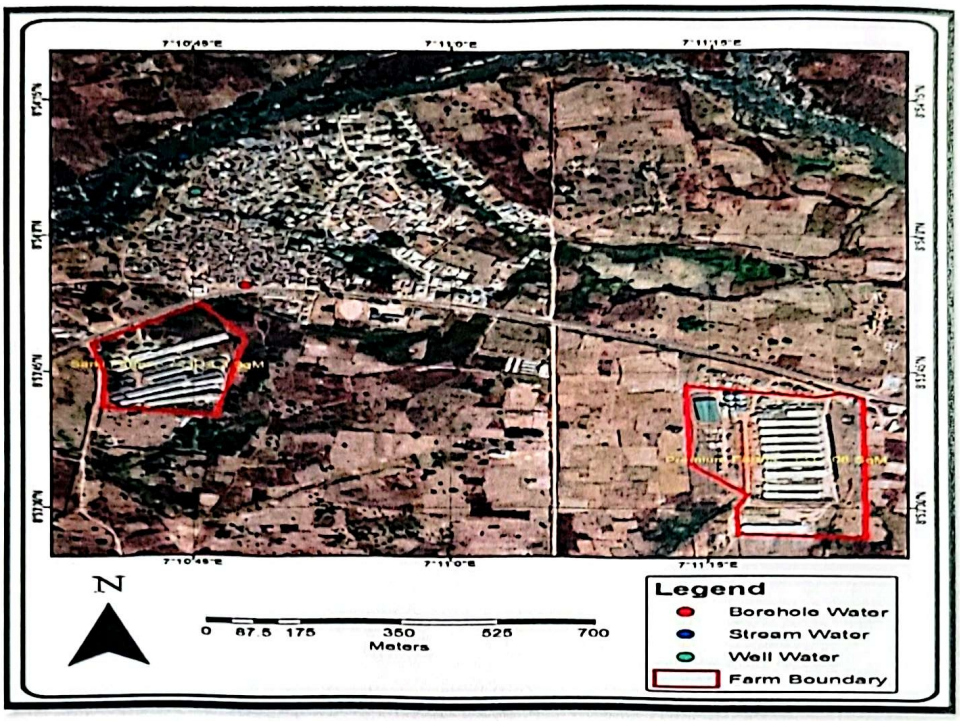

Figure 1: Satellite Image ofWater Sampled Locations in the Context of the Poultry Farms (ArGIS, 2020)

4.1.2 Impact on soil quality

The soil samples collected were tested and analysed of its Physico-chemical characteristics. The parameters test includes pH, Conductivity, Organic Carbon, Organic Matter, Total Nitrogen(N), Calcium (Ca), Magnesium (Mn), Sodium (Na), Potassium(K). and Lead (Pb). The soil samples were collected from four different locations around the poultry farms at distance of 20 meters, 40meters, 60meters apart (See map figure 2).The laboratory sample test results (Table 2) reveal presence of Calcium (Ca), Manganese (Mn) and Lead (Pb)concentration above the required WHO/NESREA guidelines at various distance to the poultry farms. Concentrations greater than this are considered hazardous. The presence of chemical parameters concentration suggests that the poultry farms activities have consequence on its operational environment. The findings are similar to Mitroi*et al.* (2021) and Wychodnik, *et al.* (2020 who found that the poultry activities pollute the soil metalconcentrations to the critical toxic level for the metals (Ca, Mn, and Pb).It also shows that the concentration of this chemicals could have adverse effects and health challenge on residents of the host farms, especially, Leadwith high toxicity and highly noxious, non-disintegrative heavy metal (Kumar et al.,2020), andparticularly dangerous for children leading to mental retardation when exist with abnormal concentration in body fluid.

Numerous studies have been conducted regarding the concentrations of metals found in poultry meat and its by-products. Previous research has documented elevated concentrations of Mn in various biological samples (Akan et al.,2010; Salwa et al.,2012). Also, studies have found lead concentrations in the gizzards and muscles of chicken meat higher than the maximum permissible limits of 1 mg/kg (FAO/WHO, 2001)(Igwemmar&Kakulu, 2022). Exposure to lead and lead chemicals mainly occurs

through ingestion of lead-contaminated food and water, dermal absorption, inhalation, and trans-placental (endogenous) routes (Nagwa and Mahmoud, 2015; Daniel, 2015). A lead concentration of 6.94 g/kg was obtained in chicken meat by Gonzalez-Weller et al. (2006). Similar results were reported for lead in poultry liver (3.15 ppm) and lean meat (3.10 ppm) by Mariam et al. (2004).

Table 2: Results of the Physiochemical and Microbiological Parameters Analysis of Soil samples.

S/NO	Parameters	Samples				WHO/NESREA Guidelines
		LAT :299844 LOG :983955 (20m) Soil A	LAT :299847 LOG :983996 (40m) Soil B	LAT :299881 LOG :984313 (60m) Soil C	LAT :300223 LOG :983969 (200m) Soil D	
1.	pH	7.53	7.66	7.58	8.04	6.5-9.2
2.	Conductivity	371	255	332	302	960µ
3.	Organic Carbon	2.15	0.57	1.3	0.79	1.5-5.0%
4.	Organic Matter	3.69	0.98	2.24	1.36	1 -5g/kg
5.	**Calcium**	**680**	**572**	**702**	**570**	75g/kg
6.	**Manganese**	**141.52**	**104.92**	**146.4**	**185.44**	5mg/kg
7.	Sodium	50.6	32.2	41.4	29.9	200mg/kg
8.	Potassium	31.2	11.7	23.4	15.6	200g/kg
9.	Total Nitrogen	0.35	0.2	0.25	0.28	10g/kg
10.	**Lead**	**4.42**	**2.16**	**4.1**	**3.65**	0.01-1.0mg/kg

Source: Authors Field Survey, 2020

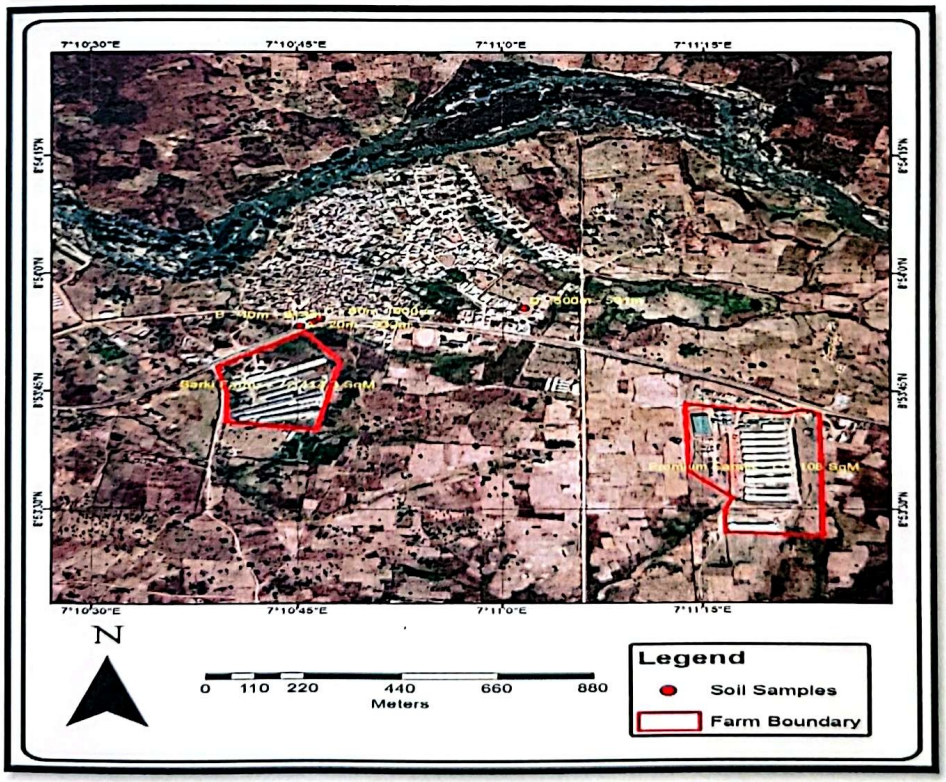

Figure 2: Satellite Image of Soil Sample Locations in the Context of the Poultry Farms (ArGIS, 2020)

4.1.3 Impact on Air Quality

The air quality analysis around the integrated commercialpoultry farms and the communities revealed the presence of pollutants P.M2.5, Sulphur Dioxide (SO2) and Carbon Monoxide with adverse health effect.

a) Particulate Matter (P.M2.5)

The level of Particulate matter (PM2.5)was measured, before production at about 8.00am and after production around 5:00pm. During production hours, the air quality was measured at four basic point from the poultry farm fence at an interval of 20meters, 40meters and 60meters. The results reveal 245µg/m³and 243µg/m³ concentration of particulate matter (2.5) at the fence of Sarki and Premium farms respectively.At 20meters away from the fence,Sarki farm (254µg/m³) and Premium farm (252µg/m³), 40meters away was recorded (236µg/m and 229µg/m³) and 60meters away (280µg/m and 275µg/m³) respectively at hour beforeproduction. Similarly, measure after production hours reveal that, at the fence of both Sarki (247µg/m³) and Premium farms (244µg/m of PM2.5 were recorded.At 20meters away (232µg/m and 235µg/m³), 40meters away (250µg/m³and 249µg/m³) and at 60meters away (273µg/m³ and 281µg/m³) were respectively recorded as presented in Table 3. The results show that, at the poultry farms fence and distance range of 20 - 40meters away from the poultry farms, the recorded PM2.5 before and after hours of production were within or below the recommended benchmark of 250µg/m³ by Ministry of Environment. However, the air quality analysis at 60meters distance from the poultry farms reveal the presence of concentration of PM2.5 above therecommended benchmark before and after hours of production.

The variation in particulate magnitude could potentially be attributed to the velocity of wind and the dissemination of particulate matter originating from poultry farm production activities. The detection of particulate matter pollutants emanating from poultry farms serves as evidence of the impact of their operations on the surrounding environment. The particulate matter (PM) present in poultry housing originates from various sources including organic, inorganic, and biological. The aforementioned substance is a composite of both solid and liquid components, comprising of bedding materials, feathers, feed, skin, excreta, dander, and microorganisms. Around 90% of the organic material present in poultry houses is constituted by particulate matter (Bist& Chai,2022).Particulate matter pollutants have adverse effects on residents of which could lead to health effects (both chronic and acute) respiratory conditions such asbronchitis, asthma in children, heart disease, and lung cancer in the study area.

Table 3 RecordedParticulate Matter (PM2.5) around Poultry Farms

Poultry Farms	Production Hour	Air Sample Distance from Farms				FMENV Limits
		Fence	20 meters	40 meters	60meters	
		Source:299842°E 983955°N	Source:299842°E 983955°N	Source:299847°E 983996°N	Source:299910°E 984003°N	
A (Sarki)	Before	245µg/m³	254µg/m³	236µg/m³	**280µg/m³**	<250µg/m³
	During	247µg/m³	232µg/m³	**250µg/m³**	**273µg/m³**	
B (Premium)	Before	243µg/m³	**252µg/m³**	229µg/m³	**275µg/m³**	
	During	244µg/m³	235µg/m³	249µg/m³	**281µg/m³**	

Source: Authors Field Survey, 2020

b) Sulphur Dioxide (SO_2)

The concentration of Sulphur Dioxide (SO_2) during and after production hours(manufacturing). During production hours, the air quality measured at four distance points from the fence reveal various in recorded concentration of SO_2. At both Sarki and Premium farm fence 0.05ppm and 0.03ppm of SO_2concentration were observed.At distance of 20meters away from the fence, 0.07ppm and 0.05ppmconcentrationof $SO_2$was recoded respectively (Table 4). While at 40meters away (0.07pm and 0.06ppm) and 60meters distance(0.3ppm and 0.5ppm) of SO_2concentration recorded among the farms respectively during production hours. The record shows high concentration of SO_2above(*>0.01ppm*) recommended standard at production hours. Similarly, 0.04ppm and 0.07ppm of SO_2 concentration recorded after production from the fence of both farms (Sarki and Premium). At distance of 20 meters away (0.04ppm and 0.05ppm), 40 meters away (0.1m and 0.2ppm) and at 60 meters away (0.2ppm and 0.3ppm) concentration of SO_2 were recorded respectively for the two farms. The concentration of Sulphur Dioxide (SO_2) at 40meters distance from the fence exceeded the permissible limit of 0.1ppm for farm 'B'. However, before and after production hour record of the Sulphur Dioxide (SO_2) concentration at 60 meters distance from the poultry farms exceeded the permissible limit of 0.1ppm, thus, poses environmental concern.The analysis of SO_2 concentration reveals the impact of wind direction on pollution levels, as evidenced by the results.

Table 4 Sulphur Dioxide (SO2) Observed in the Air around Farms

Poultry Farms	Production Hour	Air Sample Distance from Farms				FMENV Limits
		Fence	20 meters	40 meters	60meters	
		Source:299842°E 983955°N	Source:299842°E 983955°N	Source:299847°E 983996°N	Source:299910°E 984003°N	
A (Sarki)	Before	0.05ppm	0.07ppm	0.07ppm	**0.3ppm**	0.1ppm
	After	0.03ppm	0.05ppm	0.06ppm	**0.5ppm**	
B (Premium)	Before	0.04ppm	0.04ppm	**0.1ppm**	**0.2ppm**	
	After	0.07ppm	0.07ppm	**0.2ppm**	**0.3ppm**	

c) Carbon dioxide (CO_2)

The volume of Carbon dioxide (CO2) in the air samplewas also measured, before, during and after production hours (manufacturing or processing) from the fence at an interval of 20 meters, 40 meters and 60 meters away from poultry farms. Table 5 present the result of the Carbon dioxide (CO2) in the air around poultry farms. The results show that Carbon dioxide (CO_2)concentrationin the air at both Sarki and Premium farms withinpermissible limit by the farm fence and at the distance of 20meters - 60 meters away from the farms for all operation hours. However, a higher concentration of CO_2 was recorded at 60meters away from the both poultry fence during production hour, above the recommended standard of 10ppm by the Federal Ministry of Environment (2008).The observed increase in concentration could potentially be attributed to the discernible impact of wind direction on carbon dioxide concentration. The concentration of carbon dioxide is observed to increase due to wind-driven mechanisms, and subsequently, it is dispersed throughoutvarious regions (Al-Bayati*et al.*,2020).Thus,poultry farms pollutanthas adverse effects on the environmentcausing greenhouse effect. The source of the CO_2 concentration in the air quality as a result of the poultry production activities through machines processing chicken feeds, shelter for poultry, fuel used for heating and transport, burning of vegetable waste.

Table 5: Volume of Carbon dioxide (CO2) in Air around Poultry Farms

Poultry Farms	Production Hour	Air Sample Distance from Farms				
		Fence	20 meters	40 meters	60meters	
		Source:299842°E 983955°N	Source:299842°E 983955°N	Source:299847°E 983996°N	Source:299910°E 984003°N	FMENV Limits
A (Sarki)	Before	2ppm	4ppm	6ppm	9ppm	10ppm
	During	4ppm	6ppm	8ppm	7ppm	
	After	2ppm	3ppm	5ppm	6ppm	
B (Premium)	Before	2ppm	4ppm	6ppm	9ppm	
	During	4ppm	6ppm	**10ppm**	8ppm	
	After	2ppm	3ppm	5ppm	6ppm	

5.0 Conclusions and Policy Implications

The study has shown that the urban poultry farms activities have adverse impacts on the host environment. Findings reveal that the urban poultry farms in Chibri area, suburbia of Kujeare source of external environmental pollution.The resultant environmental pollutionhavesignificantly increased the risk to human health with the growth and development of the settlements with the poultry farms. Livestock and poultrypollution is a potential danger to human health, and it needs to be seriously considered.In view of the findingsobtained from the water, soil and air quality analysis in Kujesuburbia,the following policy recommendationwere made:

i. Government and the Poultry farms should embark on public enlightenment campaigns to the residents around the poultry farms, with a view to educate them about the negative impacts of the poultry farm operations to their health as well as source of water, farm land and air quality in their environment.
ii. Reviewing of the existing planning approval system, to re-assess impact through timely environmental auditing to reduce production impacts of the poultry farms on both public health and environment.
iii. Poultry activities that could lead to environmental pollution should be disallowed.
iv. Strict development control measures should be put in place, by restricting residential development close to the poultry farms or develop a green buffer zone to mitigate direct effect on residents environmental.
v. This study should serve as a baseline study for Policy makers and Town Planners. As it is the work of Planners to reduce or mitigate public health and environmental risk hazard/ disaster.Poultry farms should not be sited close to residential areas.
vi. Poultry farm operators should sensitize that the parameters of the prescribed by regulatory agency do not exceed the effluent limitations.
vii. The Council and planning authorities should enforce stipulated appropriate distance between poultry farms and residences by regulation. This will help to mitigate the effects of environmental pollution /health hazards.

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