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Utilizing Farmland Surveying and Geoinformatics to Support Decision-Making for Mitigating and Managing Environmental and Land-Use Conflicts in Farming Communities of Imo State, Nigeria"

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ABSTRACT

The majority of resource disputes arise from boundary disagreements, competing claims to property, issues surrounding rights, control, and inheritance. This paper thus examines how farmland surveying and geoinformatics can mitigate conflicts in Imo state, Nigeria. It highlights the causes of land disputes, the impacts of farmland conflicts, the role of farmland surveying in alleviating these issues, and the challenges farmers encounter when surveying their properties. A sample of 140 farmers from areas experiencing land conflicts in Imo state was randomly chosen. Descriptive statistics were utilized for data analysis. The findings indicated that 50% of the respondents are aged between 51 and 60 years, with 70% having had their farms surveyed and over 21 years of experience in farming. The identified causes of conflicts consist of rapid population growth (88.6%), inheritance disputes (97.1%), farmland encroachment (100%), unclear boundary delineations (96.7%), and land grabbing (96.4%), among others. The effects, with a mean response of (M) 2.50, include an increase in crime rates (M=3.40), environmental degradation (M=3.31), diminished economic growth (M=3.10), and lower agricultural productivity (M=2.81), among others. Farmland surveying helps to reduce conflicts by establishing clear and precise land boundaries (M=2.81), enabling farmers to invest in their land, providing proof of ownership (M=2.89), securing property rights (M=2.57), offering expert testimony in court (M=2.79), and preventing land encroachments (M=2.61), among other benefits. The challenges encountered include a lack of perceived necessity for land surveys (92.8%), the expense associated with surveying farmland (100%), limited access to surveying technology (88.6%), insufficient prioritization (91.4%), and existing knowledge of boundaries (85%), among others.

INTRODUCTION

There is a widely accepted view that food is crucial for human life and survival. The current food economy fails to provide sufficient nourishment to significant segments of the expanding global population, despite substantial growth rates. Food security has emerged as a significant issue in both developing and developed countries, drawing attention to major disparities as well as contradictions and tensions between scarcity and wealth. The food system can be viewed as a lens reflecting the intersection of sustainability and equity. This system determines our diet; however, concerns have been growing across all levels of governance and in various policy sectors, civil society, academia, and business that the food system is unsustainable and jeopardizes the health and future of our planet. "Food systems include activities related to the production, processing, distribution, preparation, and consumption of food; and the results of these activities affect food security (Dogondaji, 2013). These outcomes also impact environmental and other security issues (e.g., income) (Ahsan, 2008).

In recent years, the agricultural sector has transitioned from a relatively overlooked area to being a focal point in climate change discussions. Over time, adapting agricultural food systems to escalating climate changes has rapidly become one of the key challenges within the sustainable development agenda. Climate acts as a crucial factor influencing the performance of food systems at the farm level, impacting both the quantity and variety of food produced as well as the viability of production-related income. Extreme weather conditions can impair or demolish transport and distribution infrastructure, adversely affecting other non-agricultural segments of the food system.

Increasing attention is being given to the lack of food security and coping mechanisms being researched in Africa. Food insecurity has been recognized as a major challenge facing many African governments, exacerbated by an increasing population living in poverty, widespread corruption, incidences of conflict and terrorism, and adverse climate conditions in the region. Nigeria has one of the highest numbers of people living in extreme poverty globally and is confronting food insecurity, particularly in the northeastern and north-central regions, where conflicts, insurgency,

kidnapping, armed banditry, cattle rustling, and extreme weather conditions are worsening the food security crisis (Ayinde et al, 2020). To create a sustainable food system that is socially equitable despite challenges posed by climate change, comprehensive and strategic approaches are essential. A critical aspect of this is enhanced cooperation among climate, agriculture, and food security sectors, along with evaluating interdependencies across entire food systems and landscapes (Hall and Dorai, 2010).

Food security is essential for the survival of humanity and for economic activities such as food production. Food is unique among commodities because it is vital for survival and existence. In Nigeria, a significant level of food insecurity has persisted for the past four decades due to a neglect of food production as oil has become the major export product. Factors such as neoliberal economic policies like naira devaluation, trade liberalization, and the withdrawal of government involvement in economic activities, along with ethnic and religious conflicts and disasters such as floods and droughts, have also contributed to food insecurity (Alagbe and Adefowope, 2022). Food stands apart from other commodities since it is necessary for everyone's survival and plays a key role in a nation's aspiration for prosperity. Unfortunately, the majority of food in Nigeria is produced by small-scale farmers who lack adequate capital, skills, energy, and other resources needed to grow sufficient quantities of food to meet the demands of the growing population. Consequently, food insecurity remains a persistent and double-digit issue in Nigeria.

Food inflation in Nigeria was 12.07 percent on average from 1996 to 2021, as reported by 'Trading Economics,' an independent economic forecasting consortium, with a peak of 39.54 percent in September 2001 and a low of -17.50 percent in January 2000. In March 2021, it rose to 22.95 percent, before declining to 17.76 percent in June. Food insecurity, closely associated with malnutrition, severely impacts the underprivileged population (Alagbe and Adefowope, 2022). Nigeria possesses 70.8 million hectares of agricultural land, yet only 34 million hectares are suitable for farming. Large areas of potentially cultivable land remain unused, while the population continues to face hunger and poverty. Although the agricultural sector employs 35% of the population and 70% of households are engaged in crop farming (Nations

Encyclopedia, 2011), farm output is inadequate to meet the food needs of the masses, especially in comparison to countries such as Canada, where only 0.79 percent of the population works in agriculture, yet it stands as one of the largest food producers and exporters globally. Daily, many individuals experience hunger or malnutrition due to a lack of access to food or an inability to afford it.

The worsening food crisis in Nigeria is intensified by increasing security threats and institutional weaknesses. While climate change affects the environment and farming communities, war and conflict have recently caused significant harm. The conflict between farmers and herders is often cited as a central factor contributing to food insecurity in the nation. Farmers face dangers due to attacks, while the destruction of farmland compounds the issue. The insurgency disproportionately impacts farmers in the Northeast, with 10.6 million people requiring urgent assistance, yet only 7.8 million can receive it. A Cadre Harmonisé report from November 2019 estimated that around 2.6 million individuals in Adamawa, Borno, and Yobe states endure severe food insecurity, which is a reduction of over 300,000 people since June 2019. If humanitarian aid is not provided, approximately 3.6 million people in these three states will face extreme food insecurity from June to August 2020, a situation that is similar in many other Nigerian states (Alagbe and Adefowope, 2022).

The growth of the country's population negatively affects its agro-ecological systems. Significant environmental issues, such as deforestation, desertification, soil degradation, erosion, flooding, loss of habitat, and depletion of natural resources exist in the country. The sandy desert is advancing south at a rate of 0.6 km annually in the northern region, while the rainforest area in the south has shrunk from nearly 10% of the country's total size in 1934 to just 5% today (Alagbe and Adefowope, 2022). These critical concerns are further exacerbated by their impact on the nation's food security. Notably, increased heat and water stress threaten the overall agricultural capabilities of the country, posing a serious risk to food security at both national and household levels.

Food demand in Nigeria has outstripped food supply (Idrisa et al., 2008), with the CBN (2001) affirming that the annual food production growth rate of 2.5

percent does not keep pace with the annual population growth rate of 2.8 percent. Many Nigerian farmers are poorly informed, lack sufficient agricultural inputs, machinery, and extension services, and have high levels of illiteracy, resulting in a deficiency of knowledge regarding modern agricultural methods that could enhance yields and meet the rising food demand of Nigeria's growing population. Once again, the adoption of modern technologies and practices presents a significant hurdle in Nigerian agriculture. Food waste has also been identified as a critical threat to food security in Nigeria.

As noted by Igberaese and Okojie-Okoedo (2010), Nigeria saw a food wastage of 0.81 million metric tonnes from 1995 to 2000, which could be significantly minimized with proper storage facilities. Achieving food security is unfeasible in a culture that tolerates waste. If immediate coordinated actions and solutions are not implemented, food security in Nigeria will likely face severe challenges by the year 2050 (Adebola et al., 2011), negatively impacting health, the economy, and social stability.

The World Health Organization (WHO) states that food security can be attained if everyone has access to enough safe and nutritious food year-round. Food security can be realized as long as agricultural production has increased a result of advancements in technology over the past few decades. These technologies include land use surveying and planning, geoinformatics, and land evaluation. Land use planning involves a systematic evaluation of land and water potential, options for land use, and economic as well as social conditions to identify and implement the most effective land usage strategies. The intention is to select and apply land uses that best satisfy the needs of communities while preserving resources for future generations. The impetus for planning should stem from the necessity for change, enhanced management, or a complete shift in land use driven by evolving circumstances. All types of land use are involved in this process, including agriculture, forestry, wildlife conservation, urban and industrial expansion, tourism, and amenities. Furthermore, planning provides direction in cases of conflict between competing uses by highlighting which areas hold the greatest value for specific land uses. Land use planning can be regarded as an ongoing and iterative process aimed at optimizing land resources by: assessing current and future needs while evaluating

the land's capacity to satisfy them; addressing and resolving conflicts among competing uses and requirements; developing alternative solutions and selecting those that align best with identified goals; and learning from past experiences.

On the other hand, farmland surveying is defined as the process of measuring land on farms. These measurements, conducted through tables, planes, or layouts, are intended for specific purposes. It can also be described as mapping and measuring the position, size, and boundaries of a particular area of farmland. Alternatively, farm surveying can refer to research focused on rural farmers' perceptions of agricultural production and their attitudes toward technological advancements in agriculture. Farm surveying (also known as an agricultural survey) entails an in-depth examination of the various stages of development observed over a given period concerning agricultural growth and the quantity of produce generated during that time frame.

It includes the following aspects: identifying areas that are suitable for the development of agriculture, forestry, range management, wildlife conservation, recreation, urbanization, or industrial ventures; selecting viable land use alternatives and appropriate crops for different sections of a project area, as well as developing suitable cropping patterns; prescribing land management practices that maximize agricultural yields while ensuring optimal conservation of land resources; forecasting crop yields and agricultural productivity in a specific area or region under specific management practices and input levels; and planning for regional or national food and fiber requirements over the long term. The assessment of potential changes or environmental risks such as soil erosion, drought, salinization, water-logging, and depletion of soil fertility, in relation to the anticipated development of an area or future modifications in land usage; Selection of suitable locations for agricultural research centers/experimental farms and pilot initiatives; Practical application of agricultural research and outcomes from the pilot programs; Assessment of land development needs and expenses for a chosen project area, along with the formulation of land development schemes; Execution of agricultural and land development initiatives; Estimation of projected income and net financial advantages from the execution of a farming project; Determining water needs for irrigating a project area; Efficient allocation

of irrigation water resources; Valuation of land for consolidation, exchange, agricultural tax purposes, and the advancement of agricultural loans; Planning for the restoration of degraded lands, such as those affected by soil erosion, salinity/acidity, waterlogging, etc. Alignment and planning of roads, railways, irrigation channels, drainage systems, and flood control embankments, among others; Site selection for irrigation reservoirs, airstrips, waste disposal sites for industrial residues, etc.; Location of agro-based enterprises; International collaboration in agricultural research and land management technologies; Securing development funding from international donor organizations for agricultural endeavors.

A geographic information system (GIS) is a software application designed to document, store, validate, and present data related to locations on the Earth's surface (Maguire, 1991). A GIS can display various types of information, such as streets, structures, and vegetation, all on one map. This allows individuals to perceive, evaluate, and understand structures and relationships more easily. GIS is instrumental in precision agriculture due to its ability to facilitate data collection, storage, retrieval, and analysis related to features and locations, as well as its role in providing data-driven solutions, particularly in site-specific management. Unlike traditional maps, digital GIS maps incorporate multiple layers of data, each depicting a particular characteristic, such as yield, pest infestation, nutrient levels, soil assessments, rainfall data, and more. Additionally, GIS provides analytical capabilities to uncover relationships between features through statistical methods and geospatial analysis. The insights gained are valuable for decision-making in management practices. GIS plays a crucial role in ensuring food security in a world facing significant challenges from population growth, resource limitations, agricultural land scarcity, and climate change. GIS offers powerful tools to navigate the complexities of food security by enhancing precision in agriculture, optimizing resource distribution, and reducing risks. By connecting geographical data with agricultural decision-making, GIS allows farmers to minimize their environmental footprint while maximizing resource efficiency. Tailoring precision agriculture techniques to specific field conditions, this technology-driven approach contributes to improved efficiency and increased production.

The sustainability of agricultural production systems has thus become a critical issue for agricultural researchers and policymakers in both advanced and developing countries (Rossister, 1994; Medugu, 2006; 2006; IIIA, 2008; Alademerin and Adedeji, 2012). To devise an effective sustainable strategy for agricultural development, it is vital to ascertain the existing potential through land and land use planning. Land evaluation involves assessing the performance of land when utilized for a particular purpose, which encompasses conducting and interpreting surveys and studies of topography, soils, vegetation, climate, and other land-related factors to identify and compare promising types of land use relevant to the goals of the evaluation (F.A.O 1976). Land evaluation has garnered the attention of numerous scholars in Nigeria (Mbajiorgu and Anyadika, 1997; Akinbola et al., 2008; Babalola et al., 2011; Uchua and Nduke, 2011; Uchua et al., 2012). These research studies employed GIS and remote sensing mapping capabilities to analyze agricultural systems. However, various contemporary factors such as climate change, rising population, HIV/AIDS and related health issues, rural-to-urban migration, and the availability of hybrid species impact the contribution of agriculture to Nigeria's economic growth (Anthony, 2010). These factors have not been sufficiently addressed in land evaluation studies across Nigeria.

The global demand for land for agricultural purposes is rising, indicating a scarcity of land resources. This situation has created a need for informed decision-making aimed at achieving the most advantageous use of limited land resources. Evidence-based choices made for the optimal use of land resources have significant implications for conserving these resources for future generations. The role of land evaluation in this context is to enhance the understanding of the relationship between land conditions and the purposes for which it is used, providing planners with comparative analyses and promising alternative options (Njar et al., 2012). The data and suggestions arising from land evaluation are essential for the land-use planning process that usually follows (George, 1997).

Land-use evaluation identifies viable land use options that are critical for effective land use planning. Van Diepen et al. (1991) defined land use planning as the distribution of land to various uses in accordance with criteria established during the land evaluation process. In assessing land use options, it is crucial to take into account

management-related aspects (George, 1997). This is due to the fact that management-related attributes, including inputs and socioeconomic conditions, can influence production levels. Land-use planning can serve as a proactive measure to prevent or address land degradation both prior to and during agricultural activities. When conducted before any agricultural investments, land-use planning aids in pinpointing suitable regions for particular types of activities. This evaluation process, which forecasts land performance based on specific uses over time and across different areas, is referred to as agricultural land suitability evaluation (Sonneveld et al. 2010; Elsheikh et al. 2013). It highlights the strengths and weaknesses of land for crop production (Pan and Pan 2012), especially as continuous agricultural land use and climate change consistently reduce land productivity and resources (Elsheikh et al. 2013; FAO 2007). Thus, agricultural land-use planning offers viable solutions to issues related to land quality, the selection of appropriate cultivation techniques, and the decision-making process regarding ideal land management. In this context, land-use planning enhances the efficient use of water, facilitating the continued utilization of farming systems throughout both the rainy and dry seasons. Its role in food security depends on the ongoing availability of food resources.

Environmental resource conflicts among farmers in Imo State are becoming more common and increasingly complicated. These disputes typically stem from ambiguous farmland boundaries, overlapping land claims, encroachment on neighboring properties, and arguments over access to communal land and water resources. The ongoing use of traditional boundary descriptions, oral histories, and inconsistent measurement methods complicates the establishment of legally sound and technically precise land information. Many rural communities in Imo State use outdated land administration practices, which often feature inadequate documentation, limited adoption of modern surveying technologies, and poor integration of spatial data into land management systems. As a result, dispute resolution frequently relies on subjective interpretations, lacking verifiable spatial evidence. This leads to extended conflicts, diminished agricultural productivity, strained social relationships, and sometimes even violent confrontations. Although geospatial technologies and trained professionals are available in Nigeria, their

use in farmland surveying and geoinformatics for preventing and resolving conflicts at the grassroots level is still quite limited. Thus, there exists a significant gap in knowledge and practice regarding the systematic application of farmland surveying and geoinformatics to alleviate environmental resource conflicts among farmers in Imo State.

After agricultural activities are completed, land-use planning also creates a framework for land restoration. This branch of land system science can contribute to sustainable outcomes through an integrated evaluation of land availability and the trade-offs linked with agricultural expansion and intensification of land use (Verburg et al. 2013). Consequently, land-use planning pinpoints effective actions for proper investment. Thus, it will significantly aid in the goal to "double the agricultural productivity and incomes of small-scale food producers, particularly women, indigenous peoples, family farmers, pastoralists, and fishers, through secure and equitable access to land, other productive resources and inputs, knowledge, financial services, markets, and opportunities for value addition and non-farm employment by 2030" (SDG2). Environmentally, land-use planning plays a crucial role in preserving ecosystem services and functions. Low fertilizer usage helps reduce pollution, while a comprehensive approach to implementing food systems would greatly enhance the diversity of food sources and their availability. Therefore, farm surveying and Geoinformatics are current tools for proper land management, secure access and agricultural intensification. Despite the above, there is no empirical data on the subject in the study area, even though environmental conflicts exist.

The specific objectives include to:

a). ascertain the causes of environmental resource conflicts in the study area;

b). examine perceived effects of environmental resource conflicts in the study area;

c). ascertain perceived roles of farm surveying in reducing environmental resource conflicts;

d). identify perceived roles of Geoinformatics in reducing resource conflicts in the area;

e). examine the challenges facing farmers in farm surveying and use of Geoinformatic tools.

MATERIAL AND METHODS

Imo State is located between latitudes 4°45'N and 7°15'N, and longitudes 6°50'E

and 7°25'E, encompassing an area of roughly 5,100 square kilometers (fig.1). It is bordered by Abia State to the east, the River Niger and Delta State to the west, Anambra State to the north, and Rivers State to the south. The state is rich in natural resources, including crude oil, natural gas, lead, and zinc. It is also home to economically significant plant species like Iroko, Mahogany, Obeche, Bamboo, lush grasses appealing to herdsmen, rubber trees, and oil palms (IMSG, 2010; NPC, 2006). The rainy season begins in April and lasts until October, with annual rainfall varying from 1,500mm to 2,200mm (60 to 80 inches). The average annual temperature surpasses 20 °C (68.0 °F), leading to an annual relative humidity of 75%, which can reach 90% during the rainy season. The dry season includes two months of Harmattan from late December to late February, with January to March typically being the hottest months. The estimated population is approximately 5.8 million, and the population density ranges between 230 and 1,400 individuals per square kilometer (IMSG, 2010). Both primary and secondary data sources were used, with primary data collected through questionnaires and supported by oral discussions. Descriptive statistical techniques such as mean and standard deviation were applied to achieve the study's aims. A three-stage sampling method was utilized for sample selection. The first stage comprised the purposive selection of three areas within the state known for farmer-pastoralist conflicts, specifically Ohaji/Egbema, Owerri West, and Okigwe Local Government Areas. The second stage involved the purposive selection of communities that had faced these conflicts, including Awarra and Umuapu (Ohaji/Egbema), Irete (Owerri West), and Ihube (Okigwe). The final stage included proportionate selection of 40 crop farmers from a group of 400 impacted farmers in Awara, 34 crop farmers from 340 in Umuapu, 35 affected crop farmers from 351 in Ihube, and another 30 farmers from 300 in Irete. This culminated in a total sample size of 140 crop farmers drawn from a household list of 1,400 affected by the conflicts. The sampled household heads included widows who manage to support themselves and their families. Percentages presented in frequency tables were utilized to address objectives 1 (causes of environmental resource conflicts) and 5 (challenges of farmland surveying and geoinformatics). Furthermore, mean values were calculated for objectives 2, 3, and 4, which explored the perceived impacts of

resource conflicts, as well as the role of farmland and geoinformatics in mitigating these conflicts, assessed using a 4-point Likert scale ranging from strongly agree to strongly disagree, with corresponding values of 4, 3, 2, and 1. The total values were averaged by dividing by 4 to obtain a distinguishing mean value of 2.50. Any mean equal to or exceeding 2.50 was categorized as effects or roles of farmland survey and geoinformatics in lessening resource conflicts.

Figure 1: Map of Imo State showing the Local Government Areas of study

RESULTS AND DISCUSSION

Causes of Environmental Resource Conflicts in the study Area

Table 1 showed the various reasons/causes of land and environmental resource conflicts in the study area. All the reasons are associated with, or the cause of one institutional failure or the other. These include inheritance issues (97.1%) which happen when inheritance to land is being contested or challenged. The traditional institution that regulates norms, laws, and values may have failed to function appropriately. Land encroachment (100%), changes in land use (77.1%), inaccurate or outdated property surveys (83.6%), unclear boundary delineation (95.7%), absence of

survey boundary markers (92.8%), overlapping land rights (86.4%), denial of access to land (92.5%) are all reasons why land conflicts occur in the study area.

Other reasons include Land grabbing (96.4%), by powerful and influential persons, communities or government institutions, failure to keep old agreements (100%), especially in the native lands and cultural agreements where land is given out on trust, after observing certain traditional rights, and libations, poured. Rising land values (97.1%) could make holders of less land areas jealous of those with large tracks of land, due to the high market value of land. Inequality in access to land (91.4%), resource competition (92.5%), unclear/unidentified rights to land (95%), have been said to cause land conflicts in the area. High population growth (88.6%) is also a cause of land conflict in the study area. A significant population growth or increase leads to greater pressure and demand on land for multi purposes. Urbanization (72.1%) resulting in indiscriminate clearing of land for development purposes, weak land administration institutions (93.6%) and inadequate documentation systems (89.2%) are all causes of land conflicts.

Oral discussions with farmers reveal that the main reasons for land disputes are linked to various factors, including population growth, delays in compensation, ineffective administration, competing land uses, escalating land values, and unclear boundaries, among other prevalent issues in Nigeria. As the population increases, there is a heightened demand for land, despite a limited supply. This scarcity of land, combined with high demand, creates competition, which consequently leads to conflicts. The prevalence of certain landowners, who control large parcels of land, can also exacerbate land crises. This dominance may stem from economic advantages or inheritance. Land disputes can arise from careless practices such as inadequate record keeping, unnecessary bureaucracy, and overlapping land grants. Land is considered occupied when wealthy or politically powerful individuals claim ownership of land that is not rightfully theirs and start development. Such encroachments often occur during times of increased demand for land; some individuals may intrude on unoccupied lands that are legitimately owned or earmarked for public amenities like schools, parks, hospitals, and communal spaces. Inefficient land use practices can also trigger disputes, especially

when pastoralists and farmers attempt to coexist on the same land in rural areas. Livestock can damage crops, leading to conflicts between individuals, groups, or communities. Numerous sources of land conflicts are tied to the rising value of land. The economic potential of land, particularly in urban business districts recognized as prime investment areas, tends to rise significantly. The increase in land value is driven by factors such as technological advancements, better accessibility, and economic shifts. The growing prices and demand for land can lead to widespread conflicts. Moreover, poorly defined boundaries present another challenge, particularly in regions with insufficient planning. In these unplanned and unmeasured areas, individuals often delineate boundaries with markers like stones or trees. Over time, these markers may be changed or removed, resulting in boundary disputes. In organized areas, individuals may claim ownership of land they have illegally occupied. Other factors that contribute to land conflicts include forged documents and misunderstandings surrounding inheritance. Some individuals buy land without officially registering the transaction, not realizing that land transactions should be treated like other commodities. Certain real estate agents may fraudulently sell the same piece of land to multiple buyers or falsely assert ownership after a certain period. It is crucial for buyers to officially register and secure ownership of the land they purchase to avoid undesirable situations.

Table 1: Causes of Land and Environmental Resource Conflicts in the Study Area

Causes of Land Conflicts	*Frequency	Percentage
High population growth	124	88.6
Urbanization	101	72.1
Inheritance issues	136	97.1
Encroachment of land	140	100
Inaccurate or outdated property surveys	117	83.6
Unclear boundary delineation	134	95.7
Changes in land use	108	77.1
Absence of survey markers	130	92.8
Overlapping land rights	121	86.4
Denial of access to land	131	92.5
Land grabbing	135	96.4
Failure to keep old agreements	140	100
Rising land values	136	97.1
Inadequate documentation system	125	89.2
Inequalities in access to land	128	91.4

Resource competition	131	92.5
Weak land administration institutions	131	93.6
Unclear/undefined rights to land	133	95.0

*Multiple Responses

Perceived Effects of Environmental Resource Conflicts in the Study Area

Table 2 showed the detrimental effects of unresolved land conflict on individuals and society. With a discriminating mean (M) index of 2.50 and above, the following effects were noticed- leads to more social conflicts (M=2.54), leads to lack of development (M=2.79), increase in crime rate (M=3.40), displacement of farm labor (M=2.78), economic instability (M=2.79), and undermine social connections (M=2.93), leads to general fear/insecurity (M=2.70), erodes social and mutual trust (M=2.68), and reduces group effectiveness/cohesion (M=2.54). Conflicts of any kind often create mistrust, tension and hostility between individuals and communities, leading to social disruption and disharmony. Unresolved land conflicts hinder investments and economic development, as investors are discouraged from investing in the uncertainty surrounding land ownership. While these go on, forced evictions, displacements leading to homelessness happen and instability suits and this provides fertile ground for criminal activities to thrive, as lawlessness and violence spread everywhere.

Land conflicts destroys communication networks (M=2.81), social assets (M=2.61), reduce economic growth (M=3.10), environmental degradation (M=3.31), reduced farm productivity (M=2.81), loss of properties & belongings (M=2.73), reduced income & savings (M=2.98), loss of human lives (M=2.58), loss of livestock (M=2.68), decrease in food production (M=2.84), separation of families (M=2.62), increase in rural poverty (M=2.76) and capital fight (M=2.90). Typically, land disputes result in interruptions to various economic activities, decreased crop yields, less usage of fertilizers, harm to infrastructure, and substantial income loss, which contributes to an increase in poverty and declines in health and education levels.

In a research conducted by Onwuegbusi and Bentina (2021) regarding the "Impact of Land Dispute on Economic Well-Being of Conflicting Communities in

Anambra State," 57.93% of participants indicated that the exit of potential investors from the community is the most significant adverse effect of land disputes on economic and sustainable growth, while only 3.25% attributed poor agricultural yields to land conflicts impacting economic and sustainable development. The majority's views are supported by qualitative data findings. During the focus group discussion (FGD) held in Nkwelle-Ezunaka, it was observed that persistent violence over land disputes between Nkwelle-Ezunaka and Ogbunike has left the land uncultivated for many years, obstructing any meaningful progress. Participants noted that no rational individual would consider buying land in an area afflicted by violence.

A participant commented that whenever land conflicts arise, any possibility of development seems unattainable. Neither individuals nor the government are inclined to invest in such areas. Land is essential for all forms of development, serving as the primary resource for production. Every aspect related to production and growth is intrinsically linked to land. The ongoing disputes over land between Nkwelle-Ezunaka and Ogbunike have greatly impeded advancement in both communities over the years. Furthermore, the study found that no significant development occurs on disputed land. The FGD in Aguleri revealed that the government does not effectively invest in dangerous areas where violence could erupt at any time and undermine any efforts made. The absence of government presence discourages private investors who could have utilized governmental support for regional development. Additionally, the land conflicts in the area have considerably hindered Otuocha's economic progress, resulting in minimal government presence, aside from the State High Court, a general hospital, and a police station. No government would invest in an area marked by violence. In these tumultuous conditions, substantial development efforts from either local residents or outside investors have been nonexistent.

Obiakor (2016) emphasized that the dangerous issue of land and boundary disputes has impeded the socio-political and economic advancement of numerous communities. Such conflicts have created increased animosity, fear, and insecurity among individuals who once had close relationships. This situation presents a serious threat to the safety and development

of the affected communities, states, and the nation as a whole. A World Bank Report (1988), cited by Uyang, Nwagbara, Undelikwo, and Eneji (2013), underscored that land serves as the foundation for agricultural production, which is crucial for sustainable development. Even today, agricultural production remains the backbone of Nigeria's economy, despite the country's focus on crude oil exploration and extraction for over fifty years. It is the main source of food for most of the population. Disagreements regarding land and boundaries carry various consequences, including loss of life, destruction of farmland and crops, as well as socio-economic and political implications. Bello (2013) affirmed that the deaths, loss of land, livestock, vegetation, and crops stemming from land disputes lead to various security, social, political, and economic challenges concerning sustainable development. The land in Sub-Saharan Africa has experienced conflict, conquest, expropriation, and exploitation, resulting in significant inequalities that contribute to socio-economic stagnation. The socio-economic conditions of various groups engaged in land disputes are frequently far from satisfactory (Bob, 2010). Clearly, no substantial development can take place in an environment marked by disunity, strife, and conflict. Development can only flourish in environments devoid of discord, division, violence, and the devastation of lives and property.

Table 2: Perceived Effects of Land/Environmental Resource Conflicts in the Study Area

Perceived Effects of Resource Conflicts	Mean	Standard Deviation
Leads to more social conflicts	2.54	0.81
Leads to lack of development	2.62	0.72
Displacement of farm labor	2.78	0.88
Increase in crime rate	3.40	0.66
Environmental degradation	3.31	0.57
Farm &home abandonment	3.01	0.91
Reduced farm productivity	2.81	0.57
Reduced income & savings	2.98	0.72
Loss of properties & belongings	2.73	0.82
Loss of human lives	2.58	0.99
Loss of livestock	2.63	0.84
Decrease in food production	2.84	0.57
Separation of families	2.62	0.67
Reduced economic growth	3.10	0.41

Capital flight	2.90	0.50
Increase in rural poverty	2.70	0.45
Disruption of social assets/amenities	2.61	0.74
Undermine social connections	2.93	0.92
Leads to general fear/insecurity	2.70	0.65
Erodes social and mutual trust	2.68	0.89
Reduces group effectiveness/cohesion	2.59	1.02
Economic instability	2.79	1.01
Destruction of communication networks	2.81	0.89

Mean Accepted 2.50 & above

Role of Farmland surveying in Reducing Land and Environmental Conflicts

Table 3 showed the veritable roles farmland surveying play to reduce land conflicts in Imo state Nigeria. With a discriminating mean (M) index of 2.50, the following roles have been identified–establishment of clear land boundaries (M=2.81), documentation of land usage (M=2.55), provision of evidences of ownership (M=2.89), improving land administration regime (M=2.87), facilitation of investment and development (M=2.74) and supporting conflict management (M=2.58). Farmland surveys provide precise mapping and delineation of property borders, assisting in conflict resolution and prevention. These surveys illustrate the extent of our land ownership. Agricultural land surveys are vital for minimizing disputes, especially in regions where traditional systems may be weak or contentious. By offering concrete, verifiable documents regarding specific parcels of land, they can help avert disagreements stemming from ambiguous boundaries or competing claims. Agricultural land surveys deter land encroachments (M=2.61), offer expert evidence in court (M=2.79), enhance communication (M=2.64), enable quick resolutions (M=2.59), diminish litigation (M=2.65), safeguard ownership (M=2.57), and promote fair and equitable land management (M=2.60). Farmland surveys, combined with title documents, establish definitive ownership and mitigate disputes over rightful land ownership. The survey plans serve as legal evidence in court to clarify boundaries and rightful ownership. Potential buyers may refer to land survey plans when purchasing property, thereby alleviating conflicts related to land. The existence of survey plans reduces the likelihood of litigation, as all features are clearly depicted in the surveys.

This aligns with the findings of Clement and Reid Associates (2023), who argued that surveyors play a vital role in resolving boundary disputes by delivering accurate, factual, and legally sound assessments of property lines. Registered land surveyors employ a combination of historical records, markers from prior surveys, land use, and sometimes descriptions to define land boundaries. Establishing boundaries is not merely a mathematical task; it is a nuanced process that necessitates an understanding of historical practices and the application of legal principles. There may be several acceptable boundary locations, and a qualified Registered Land Surveyor will identify the most appropriate choice while conveying any uncertainties to the client. This methodology reduces confusion and lays a solid foundation for dispute resolution. A professionally conducted land survey can elucidate property ownership limits, facilitate constructive discussions with neighbors, and help prevent the escalation of conflicts. Surveyors are often pivotal in spotting encroachments, such as structures that extend beyond boundary lines, or identifying easements granting others access or usage rights to portions of a property. Updated, certified surveys are essential in legal settings, acting as compelling expert evidence in court or tribunal cases. In more complex or disputed situations, surveyors may also serve as expert witnesses. Their specialized expertise and impartial evaluations are frequently sought in formal judicial settings, such as the Land and Environment Court or civil litigation. As expert witnesses, surveyors present their findings clearly and objectively, translating complex spatial information into evidence that supports fair and informed legal resolutions. Their reports and testimonies often play a crucial role in resolving boundary disputes. In conclusion, surveyors provide the essential clarity and expertise needed to foster fair, legal, and sustainable resolutions in boundary matters. Ultimately, however, it is the courts that determine the location of disputable boundaries based on the expert testimony of the Registered Land Surveyor.

Table 3: Farmland survey Role in Reducing Land and Environmental Resource conflicts

Roles of farmland survey in conflicts Reduction	Mean	Standard Deviation
Establishments of clear land boundaries	2.81	0.81
Documentation of land usage	2.55	0.58
Provision of evidence of ownership	2.89	0.64

Improving land administration require	2.87	0.94
Facilities of investment & development	2.74	0.83
Supporting conflict management	2.58	0.94
Preventing land encroachment	2.61	0.81
Expert evidence on court	2.79	0.57
Improved communication and collaboration	2.64	0.44
Facilitating fast resolution	2.59	0.57
Reduces litigation	2.65	0.78
Source property ownership	2.57	0.81
Fair and equitable land management	2.60	0.51

Mean Accepted 2.50 & above

Roles of Geoinformatics in Land and Environmental Resource Conflict Reduction

With a discriminating mean index (M) of 2.50 and above, table 4 showed the roles of geoinformatics in reducing land and environmental resource conflicts. These roles include aiding stakeholders to make informed and sound decision (M=2.58), spatial visualization of conflict prone areas (M= 2.67), identification of resources causing conflicts (M= 2.81), proximity analysis/digital mappings (M=3.01), identification of conflict affected populace (M=2.81), provision of information for preventing conflicts (M=2.80), and making accurate conflicts prediction (M=2.70). Other roles include developing dataset for vulnerability assessment (M=2.60), border demarcation between opposing groups (M=2.59), ground water and water quality assessment (M=3.01), water shed/surface water management programmed (M=2.88), and identifying cattle routes and vegetation change (M=2.70).

Some proponents of Geographic Information Systems (GIS) argue that it could help mitigate land conflicts among competing interests concerning spatial policies by improving access to information. The emergence of user-friendly desktop applications has made GIS increasingly popular in recent years, driven by a growing interest in related applications and data (Huxold and Levinsol, 1991). Land disputes are particularly prevalent in many communities across Africa. Nevertheless, such conflicts can escalate into violent confrontations. Family disagreements over land have been a significant source of discord, fostering animosity, hostility, and at times leading to loss of lives and property. The most frequent types of disputes can be categorized into several groups, including

boundary conflicts, fragmentation of small land plots, competing interests from various owners, customary usage rights, challenges to prior legal decisions, and disputes over land usage for development, logging, and mining.

To realize the intended outcomes, GIS requires inputs of two types of data: geographic references and attributes. Geographic reference data comprises coordinates given as longitudes and latitudes or arranged in rows and columns. These coordinates specify the location of the provided information. Attribute data is linked to a numerical code associated with each cell or set of coordinates, representing either actual values or categorical types such as land use and vegetation. The data entry process, whether by manual typing, digitizing, or scanning, can be quite labor-intensive (Burrough, 1986; Fox and Chow, 1988). The usage of GIS for conflict evaluation, natural hazard management, and development planning is limited only by the amount of information available and the analyst's creativity. Readily accessible information regarding past events or scientific research (such as articles, newsletters, etc.) and hazard mapping can supply adequate resources for conducting preliminary GIS assessments of both natural and human-made hazards, as well as initial development planning initiatives.

On a national scale, a geographic information system can be utilized to establish a general understanding of the study area, providing planners with relevant insights into the overall conditions of hazards or conflicts and aiding them in detecting regions that need further investigation to evaluate the ramifications of the conflict. Similarly, GIS can be applied to conflict evaluations at the sub-national level to scrutinize resources and identify projects. At the local level, planners can utilize GIS to design investment projects and formulate specific strategies aimed at conflict mitigation and prevention. By integrating information concerning land conflicts, natural resources, population dynamics, and infrastructure, GIS can help planners identify areas of land conflict for resolution and promote suitable land use (Burrough, 1986). Continuing, Kyem (2000;2004;2006) suggested that Participatory Geographic Information Systems (PGIS) can enhance awareness about a conflict situation. GIS tools can assist stakeholders in overcoming their biases during mediation and foster an understanding of each other's perspectives to support consensus building. This was demonstrated in a conflict management

initiative I facilitated among groups competing for forest resources in a village in Southern Ghana (Kyem, 2004).

Today, the demand for GIS capabilities to create strategies for addressing land use conflicts has arguably reached unprecedented levels. Conflicting interests threaten resource institutions throughout the developing world. Nevertheless, the practice of employing maps to promote consensus is not a novel concept. Community development has a rich history of using maps in negotiations and conflict resolution. When community mapping is automated using GIS technology, it allows for the production of more complex maps and enables faster and more consistent updates to existing maps than ever before. If leveraged with creative applications, GIS technology can aid in resolving disputes related to resources. PGIS applications can foster collaborative approaches to conflict by analyzing maps, highlighting mutual relationships and shared interests, and nurturing common goals among the parties involved (Kyem, 2000; 2004; 2006).

Mediators can utilize GIS to alter the perceptions of different stakeholders toward each other, which may pave the way for conflict resolution. A PGIS application can aid in breaking down communication barriers and reducing the psychological and emotional pressures that prevent stakeholders from openly sharing their viewpoints. For example, this technology can play a key role in enabling stakeholders to come together to collect and analyze data, exchange resources, and discuss ideas related to a conflict situation. Additionally, PGIS applications offer the advantage of providing a recorded account of the mediation process that can be easily duplicated, stored, and shared among all stakeholders (Kyem, 2000; 2004; 2006). Thus, when effectively applied during mediation, GIS technology and applications can promote conversations that enhance understanding of the conflict context and help prepare stakeholders for reaching a consensus agreement.

Table 4: Perceived Roles of Geoinformatics in Resource Conflicts Reduction

Geoinformatics roles in reducing conflicts	Mean	SD
Aids stakeholders to make decision	2.58	0.67
Spatial visualization of conflict area	2.67	0.84
Identification of resource causing conflicts	2.81	0.74
Identification of conflict affected populations	2.94	1.01
Proximity analysis/digital mappings	3.01	0.94
Provision of information for preent6ing conflict	2.80	0.68
Making accurate conflict predictions	2.79	0.74
Develop dataset for vulnerability assessment	2.60	0.89
Border demarcation between the opposite groups	2.59	0.91
Ground water and water quality assessments	3.01	0.81
Watershed/surface water management programme	2.88	0.64
Identifying cattle routes and vegetation changes	2.76	1.02

Accepted mean = 2.50

Challenges of Surveying Farmland and Geoinformatics in the Study Area

Table 5 showed that, farmers may not survey their farmlands due to factors such as lack of perceived need for land survey (92.8%), this happens when they have used their lands for so many years and feel there is no need to survey, for formal establishment of boundary and feel secure. Cost of surveying farmland (100) is a major challenge facing farmers. This can be expensive, and prevent farmers from doing so. Others include land tenure and property rights difficulties (94.3%), limited access to survey technology (88.6%), lack of awareness (97.1%), lack of priority (91.4%), time constraints (81.4%) and limited understanding of benefits of farmland survey (90.7%). In most areas, land tenure systems are informal, property rights unclear, equipment and expertise may be lacking, especially in rural areas. Farmers may not all prioritize surveying as issues are important to them. Farmers may not also understand clearly, the benefits of land surveying and feels no need to it.

If the disputing parties fail to come to a common understanding of the data provided by the GIS, its use may negatively impact the negotiation process (Bjorkdahl and Buckley, 2016), cultivating mistrust and possibly obstructing the peace efforts. In an

environment marked by distrust, an impartial and independent GIS organization would be necessary to supply unbiased information to facilitate the conflict resolution process (Heywood et al., 2006). Hence, it is vital that GIS application in conflict resolution not only secures the collective agreement of the involved parties but also incorporates expertise and other relevant methodologies related to conflict resolution. Furthermore, in addition to the general difficulties tied to GIS applications in resolving armed conflict, challenges such as data availability, access, and the accuracy of spatial data present considerable obstacles in Developing Countries (Mennecke and West, 2001). Although many Developed Countries recognize GIS as a crucial instrument for resource management, regional planning, and economic development (Bocco and Sanchez, 1995), the implementation of GIS in numerous Developing Nations is hindered by inaccuracies and deficiencies in spatial and demographic data, along with political and management issues (Mennecke & West, 1998). For instance, Bocco and Sanchez (1995) have observed that some borders are defined by natural features such as coastlines or rivers, while others are arbitrary or historically established, leading to conflicts. The maps generated by one nation or region, outlining political or administrative boundaries, may contrast with those created by rival factions, underscoring the necessity for consensus (Baker, 2015; Wood, 2000).

Proposed strategies to tackle these issues include the development of geo-databases focused on armed conflict by the GIS departments of national governments and non-governmental organizations, which could offer dependable spatial data to support conflict resolution practitioners and policymakers in their conflict resolution and peacebuilding decisions (Hetherington, 2000; Soytong and Perera, 2014). The establishment of such geo-databases should coincide with training for GIS professionals within various organizations and institutions to manage these databases effectively (Weber, 2004). In addition to the challenges previously mentioned, including the nature of GIS, its availability, acceptance by conflicting parties, accessibility, and accuracy, Gerland (1996) pointed out various integration issues, such as data sourced from multiple origins with differing standards, missing positional and reference details, and discrepancies in geographical projections and transformations (Gerland,

1996). These matters are significant and demand trained GIS personnel for the successful application of GIS in conflict resolution (Spittaels, 2021; Weber, 2004).

Table 5: Challenges of Surveying Farmland in the Study Area

Challenges	*Frequency	Percentage
Lack of perceived need	130	92.8
Cost of farmland survey	140	100
Land tenure and property right difficulties	132	94.3
Limited access to survey technology	124	88.6
Lack of awareness	136	97.1
Lack of priority/focus on immediate need	128	91.4
Existing knowledge of boundary	119	85.0
Limited understanding of benefits	127	90.7
Time constraints	114	81.4
Suspicion of data	127	90.7
Lack of consensus	132	94.3

*Multiple Responses

CONCLUSION

Land surveying plays an essential role in minimizing resource conflicts by delivering precise, legally recognized, and objective information regarding land boundaries and natural features. This clarity on ownership helps prevent disputes and supports sustainable land-use planning, thereby reducing tensions among stakeholders vying for resources. It addresses current conflicts and prevents future ones by removing ambiguity surrounding property lines, which often lies at the heart of disputes. Geoinformatics aids in mitigating natural resource conflicts by facilitating conflict mapping, monitoring and assessing resources, and supporting data-driven decision-making and scenario modeling through tools such as Geographic Information Systems (GIS) and remote sensing. By offering spatially detailed information, these technologies assist in pinpointing areas prone to contention, tracking ecosystem health, planning for sustainable resource management, and creating strategies to alleviate disputes over scarce resources, thereby encouraging collaboration and informed management practices.

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