TOWARDS BUILDING LAND USE CO-EXISTENCE BETWEEN PASTORALISTS AND NON-PASTORALISTS IN NANUMBA SOUTH DISTRICT, GHANA

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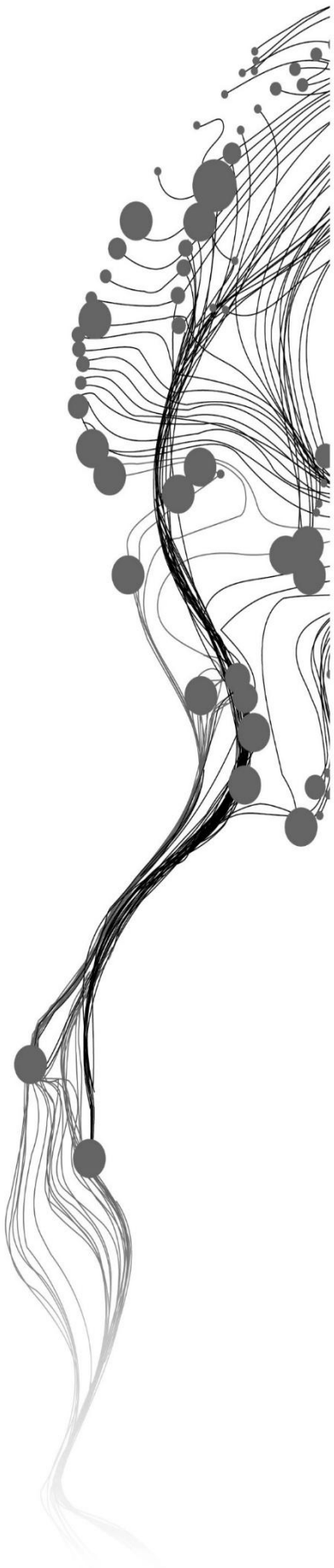

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ABSTRACT

This study explores land use conflict and co-existence between pastoralists and non-pastoralists in Nanumba South District, Ghana. It investigates how tenure systems, spatial overlaps, and local land use structures influence conflict dynamics. Using a mixed-methods approach, the research draws on qualitative data from interviews, focus group discussions, spatial data from participatory mapping, and GIS analysis. Findings reveal that while farming communities access land through relatively secure customary systems, pastoralists rely on informal, temporary arrangements with no legal recognition, leaving them highly vulnerable. Key conflict triggers include crop destruction by livestock, lack of designated grazing routes, and weak, often biased conflict resolution mechanisms.

Spatial analysis identified clear conflict hotspots, particularly where cattle routes intersect with farmland. Participatory mapping validated these findings and offered a platform for collective understanding of land use patterns. In response, the study developed a practical land use conflict resolution model. The model emphasizes participatory land-use planning, formal recognition of grazing rights, community-based zoning, and inclusive conflict resolution structures.

The research concludes that resolving land use conflict requires more than policy reform, and it demands local engagement, spatial clarity, and institutional collaboration. The proposed model presents a practical, replicable framework for managing shared land resources through a tiered conflict resolution system that integrates traditional mediation, formal advisory, and ADR mechanisms. It reinforces land use co-existence through participatory land use zoning, resource-sharing protocols, and inclusive land access agreements, ultimately aiming to reduce conflicts and improve livelihoods. This study contributes to land governance literature and offers actionable insights for district authorities, traditional leaders, and development practitioners working in conflict-prone rural landscapes.

Keywords: *Land tenure, Pastoralism, Land use conflict, Land use, Participatory mapping, GIS, Conflict resolution, Co-existence model, Nanumba South, Spatial planning*

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LIST OF ACRONYMS

ADR..... Alternative Dispute Resolution
CLS.....Customary Land Secretariat
CSRM.....Conflict-Sensitive Resource Management
ECOWAS.....Economic Community of West African States
ESRI.....Environmental Systems Research Institute
FAO.....Food and Agriculture Organization
GIS.....Geographic Information System
GSS.....Ghana Statistical Service
LULC.....Land Use and Land Cover
MIASA.....Merian Institute for Advanced Studies in Africa
PAR.....Participatory Action Research
SAGE.....Sustainable Agriculture and Environment

1. INTRODUCTION

This chapter comprises eight sub-chapters: the research background, problem statement, justification, research objectives, research questions, conceptual framework, research structure, and a chapter summary.

1.1. Research Background

Land has always been a critical resource for pastoralists and farmers, serving as the foundation for their livelihoods, cultures, and communities. For pastoralists, it serves as grazing zones that support livestock production, contributing directly to local food systems and rural livelihoods through meat and milk supply. Similarly, for farmers, land sustains families and supports local economies through crop production. However, population growth and evolving land use patterns have intensified resource-based conflicts, making co-existence between these groups vital for sustainable environments and social harmony (Benjaminsen & Ba, 2019; Lambin & Meyfroidt, 2011). For this research, the definition of land use co-existence is an equitable collaboration in land management that fosters mutual respect and effective resource utilization while minimizing conflicts. In contrast, land use conflict refers to misunderstanding fuelled by overlapping land rights, resource scarcity, or divergent socio-economic priorities (Benjaminsen & Ba, 2019). Effective frameworks addressing these issues must resolve immediate tensions while tackling systemic inequities to promote sustainable development for pastoralist and non-pastoralist communities.

The United Nations (2023) emphasizes the urgency of sustainable land management amid intensifying competition for land. Increased population growth, agricultural expansion, and climate change are key factors impairing land degradation, resource scarcity, and conflicts over land use (United Nations, 2023). Pastoralist systems central to livelihoods and food security face existential threats from rangeland degradation and overuse of land resources intensified by farming activities, and this degradation jeopardizes both pastoralist communities and the environment. However, in Africa, pastoralism represents a livelihood and a way of life that has historically supported pastoral nomadism but is now under pressure from expanding agriculture, resource competition, and climate-induced challenges like frequent droughts and reduced pasture availability (FAO, 2020; Mwangi & Dohrn, 2008). In regions such as Kenya and Ethiopia, conflicts over water and grazing resources have occasionally escalated into violence (Lengoiboni et al., 2010; Schmidt & Pearson, 2016). Similarly, in West Africa, the mobility of pastoralist groups like the Fulani heightens tensions during climatic stress, disrupting food production and exacerbating insecurity (Bukari & Kuusaana, 2018). Despite land reforms and development programs, the limited integration of pastoralist needs into policy frameworks has restricted progress.

In Ghana, traditional land tenure systems dominate rural areas such as Nanumba South, where local chiefs manage stool and skin lands. While customary land tenure systems are rooted in tradition, they often clash with the seasonal mobility of pastoralists searching for grazing lands and water. However, informal arrangements, such as fee payments or intermediary negotiations, frequently lead to misunderstandings and inequities (Bukari & Kuusaana, 2018). While Article 267 of the 1992 constitution of the Republic of Ghana and Act 1036 of the Land Act 2020 are the primary legal documents governing land use in Ghana, they do not explicitly mention pastoralists. The constitution outlines the rights and responsibilities of citizens, including land use rights, while the Land Act provides a legal framework for land tenure, use, and management. However, the provisions related to stool land management, customary law, and the oversight of land revenues could impact pastoralist land tenure and use. Suppose pastoralists rely on stool lands for

grazing; in that case, they must navigate the local customary laws and potentially make financial contributions as part of their land use, depending on local regulations (Republic of Ghana, 1992; Land Act, 2020).

Meanwhile, pastoralists in Ghana can technically own land. However, their access to land ownership is often limited by customary laws, local politics, economic constraints, and their migratory lifestyle, making it more difficult to secure land rights than in settled agricultural communities. Their access to land is usually through informal or temporary arrangements rather than permanent ownership, and these arrangements are often prone to conflict and insecurity.

Pastoralism is a cornerstone of Ghana's rural economy, supporting livelihoods through livestock production while contributing to ecological sustainability. However, unregulated transhumance practices and insufficient grazing infrastructure have fuelled persistent conflicts between pastoralists and farmers, particularly over land, water, and crops. The scale of these conflicts is alarming; between 1997 and 2017, 603 violent incidents involving Fulani pastoralists were recorded, resulting in 38 fatalities and significant property damage in hotspots such as Asante Akim North and Akatsi North (Peasant Farmers Association of Ghana, 2020). According to Oppong-Anane et al. (2018), one notable case occurred in Zamashegu, a community in the Gushegu District of northern Ghana, where a 2011 land use conflict left 30 people dead, most of them pastoralists following conflicts over grazing and farmland encroachment. These conflicts are worsened by climate-induced pressures and poor enforcement of the Economic Community of West African States (ECOWAS) Transhumance Protocol, which seeks to harmonize cross-border livestock movements (Oppong-Anane et al., 2018). Resolving these challenges requires innovative strategies, including establishing designated grazing reserves and mobility corridors that align with Ghana's ecological and social landscapes. Such solutions can reduce tensions, foster economic integration, and create a foundation for peaceful co-existence, ensuring that pastoral systems remain resilient and sustainable amid growing pressures (MoFA, 2021).

This study is a collaborative effort that investigates land use co-existence in the Nanumba South District, employing spatial analysis and participatory approaches to develop a practical model for managing competing land uses. It addresses immediate conflicts between pastoralists and non-pastoralists while examining systemic issues such as inequities in land administration, the interplay of statutory and customary laws, triggers of conflict, and the socio-economic impacts of unresolved conflicts. The research aims to contribute to sustainable land use practices that balance resource sharing, conflict resolution, and developmental needs in Ghana and similar contexts.

1.2. Problem Statement

Land use conflicts have become a critical global issue, driven by competing land demands for development, agriculture, and conservation, particularly in regions where policies do not consider diverse cultural and economic practices (Bassett, 2009). Pastoralists, who depend on mobility and communal land tenure, face unique challenges as modern agricultural practices increasingly encroach upon their traditional grazing territories. This expansion often leads to displacement, resource depletion, and heightened conflicts (Behnke, 2008). To address these challenges, the United Nations' Sustainable Development Goals (SDGs) emphasize the importance of land use harmony, mainly through Goals 1, 2, and 16, which focus on reducing poverty, ensuring food security, and fostering peace and justice, respectively (United Nations, 2023).

In Ghana, land use conflicts reflect a broader challenge as traditional land use practices, such as shared land among community or family members, increasingly clash with modern agricultural expansion, impacting pastoralist communities that rely on mobile land use. The expansion of crop farming, which limits

pastoralist access to grazing areas, intensifies tensions between pastoralist and non-pastoralist groups. This situation emphasizes the need for policy reforms incorporating cultural, historical, and ecological dimensions to support equitable and collaborative land management practices (Kuusaana & Bukari, 2015).

In the northern region, particularly the Nanumba South District, customary land practices intersect with contemporary agricultural demands with limited land resources, leading to significant ecological, social, and economic challenges. However, there has been extensive research on global land use conflicts, but a significant gap remains in studies that focus on localized cultural, social, and environmental factors shaping these conflicts. Current national land tenure policies, which often prioritize agricultural expansion, overlook pastoralists' mobility needs, creating unique challenges for land use co-existence and resource sharing (Land Act, 2020). In places like Nanumba South, farmer–herder tensions grow as farmland expands and grazing routes shrink. While policies exist, they often miss the deeper issues of land scarcity, mismatched land use, and the simple fact that different people need land for different things. Dong et al. (2021) highlight that land use conflict is not just about competition but also about how land is suited, shared, and stretched to meet diverse needs. However, local planning rarely accounts for this complexity.

This research aims to bridge the identified practical implementation and policy gaps by examining the localized factors influencing land use conflicts in the Nanumba South District. Using a combination approach that combines traditional land use management practices with conflict resolution approaches, this study will provide insights and develop a model to support sustainable land use co-existence, potentially guiding future policies for equitable land-sharing practices among diverse land users.

1.3. Justification

Land use conflicts between pastoralist and non-pastoralist communities pose significant challenges to sustainable development and peaceful co-existence in resource-scarce regions like the Nanumba South District. Despite the central role of land tenure policies in shaping these dynamics, current studies reveal a gap in inclusive analyses that integrate both traditional knowledge and modern tools to address these conflicts (Bukari & Kuusaana, 2018). Previous research has identified land use conflicts between these groups. However, it lacks actionable frameworks for fostering collaboration and co-existence of land use, particularly with modern analytical methods like spatial analysis and mapping (Bukari & Kuusaana, 2018).

The study aims to address these gaps by combining qualitative and spatial analysis methods to assess the drivers of land use conflicts, particularly those rooted in competing land tenure arrangements, identify conflict hotspots and potential cooperation areas, and develop a practical model for sustainable land management. The study will integrate local knowledge with spatial data by employing participatory methods and engaging directly with affected communities to offer insights into land use dynamics. The findings will provide a detailed policy framework for policymakers, the Nanumba South District Assembly, development partners, and non-governmental organizations to mediate and foster peaceful land use in the region (Narh, 2024; Transparency International Ghana, 2024).

To achieve these objectives, the research adopts the Participatory Action Research (PAR) approach, which prioritizes community engagement by incorporating the views of all stakeholders into decision-making processes. This ensures that the proposed solutions are practical, widely accepted, and supported by the community (Kindon et al., 2007). Additionally, the Conflict-Sensitive Resource Management (CSRM) framework provides a structured approach to addressing the underlying causes of resource competition. By integrating these frameworks, the study will offer a holistic approach to understanding and resolving land use conflicts (Ratner et al., 2013).

The spatial mapping method will identify and analyze conflict hotspots, offering detailed spatial insights into how land use patterns contribute to land use conflicts. This will complement qualitative methods, such as interviews and focus group discussions, to capture broader socio-economic and cultural dimensions of the conflicts. Together, these approaches will provide a comprehensive understanding of land tenure arrangements and land use transformation, enabling the development of a practical land conflict resolution model. This research is timely and significant as it addresses pressing land use challenges in the Nanumba South District by combining community-driven insights with technological tools to promote equitable resource sharing and peaceful co-existence. Findings from this study will fill critical gaps in the current literature and contribute to Africa's broader discourse on sustainable land use management.

1.4. Research Objectives

1.4.1. Main Objective

The study aims to identify how land tenure arrangements influence land use conflicts and land use co-existence between pastoral and non-pastoral land users in the Nanumba South District.

1.4.2. Sub-Objectives

The sub-objectives of this research are to:

1. Explore the current land tenure arrangements in Nanumba South District.
2. Examine the interactions of land use co-existence and conflicts between pastoralists and non-pastoralists.
3. Map conflict hotspots within the study area based on the spatial relationship between cattle routes, Land Use types, and reported conflict areas.
4. Develop a practical model that strengthens land use co-existence between pastoralists and non-pastoralists in Nanumba South District.

1.5. Research Questions

Objective One: Explore the current land tenure arrangements in Nanumba South District.

a. What is the current policy on land administration in the Nanumba South District?
b. What is the customary land arrangement in the Nanumba South District?
c. What policy affects the land use arrangements of pastoralist and non-pastoralist users?

Objective Two: Examine the interactions of land use co-existence and conflicts between pastoralists and non-pastoralists.

a. What factors contribute to land use co-existence and conflicts between pastoralists and non-pastoralists in shared environments?
b. How does competition over resources and land use shape the interactions between pastoralist and non-pastoralist communities?
c. What strategies or mechanisms have effectively promoted peaceful co-existence between pastoralists and non-pastoralists?

Objective Three: Map conflict hotspots within the study area based on the spatial relationship between cattle routes, Land Use types, and reported conflict areas.

a. Where are the primary cattle routes located, and how do they intersect with other land use types?
b. Which areas in the Nanumba South District experience the most frequent land-use conflicts?
c. What spatial patterns are evident between conflict areas and specific land uses (e.g., farming, residential areas)?

Objective Four: Develop a practical model that strengthens land use co-existence between pastoralists and non-pastoralists in Nanumba South District.

a. How will stakeholder perspectives be integrated into a model that promotes land use co-existence?
b. How will the proposed model be validated with identified conflict-prone areas and tested for effectiveness in reducing tensions?
c. What strategies can be proposed to improve land use co-existence between pastoralists and non-pastoralists in the Nanumba South District?

1.6. Conceptual Framework

The conceptual framework for this study includes three main components: Land Tenure and Rights Arrangements, Land Use Co-existence and Conflict Interactions, and Conflict Hotspot Mapping. These components interact to influence land use, which is an underlying factor between pastoralists and non-pastoralists. Land tenure arrangements define access rights, shaping the nature of group interactions. These interactions can lead to cooperative land use co-existence or conflict, depending on how resources are shared or competed for. Conflict Hotspot Mapping will visually represent areas where tensions are most reported, with spatial overlaps between cattle routes and other land use types. The framework will then integrate these elements to guide the development of a practical model to foster land use co-existence and conflict resolution.

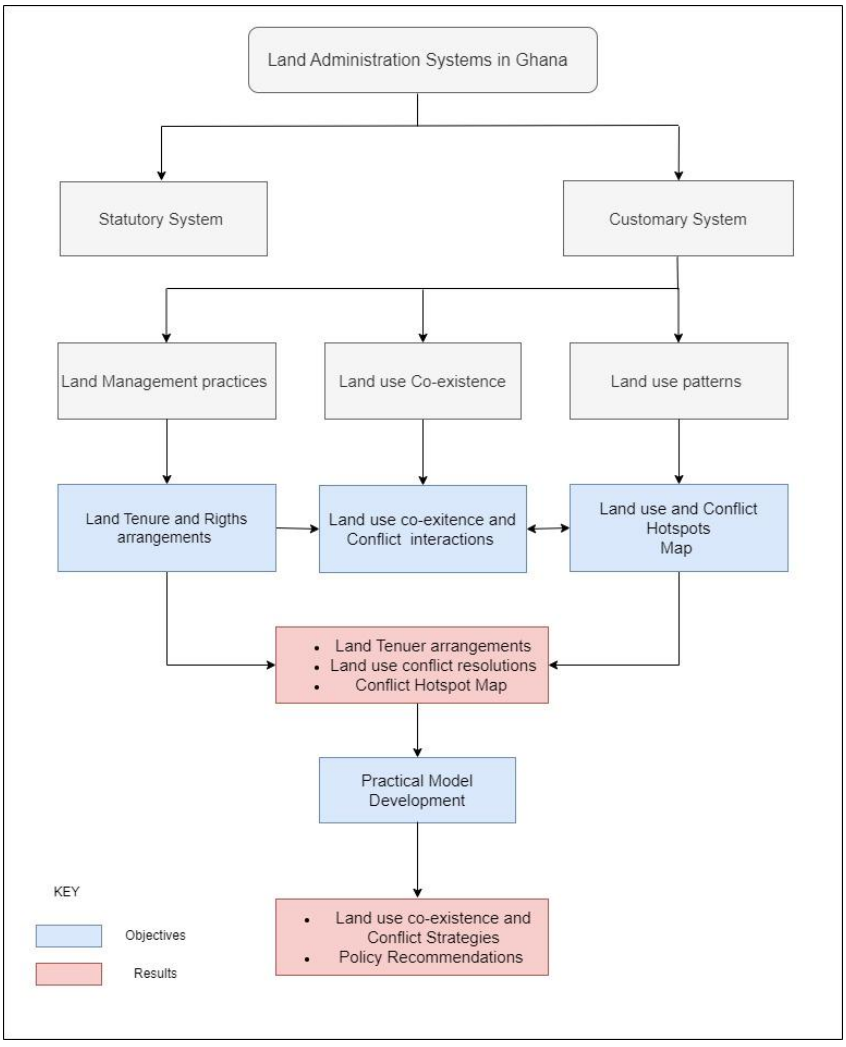

Figure 1: Conceptual Diagram

1.7. Research Structure

This thesis comprises six chapters: introduction, literature review, methodology, results and analysis, model development, and conclusion and recommendations. Chapter One lays the groundwork by presenting the background, problem statement, research justification, aim, objectives, and conceptual framework. Chapter Two explores the theoretical and empirical foundations of the study, focusing on land use co-existence, land use conflict, governance of land tenure systems, and the use of GIS and participatory frameworks in conflict resolution. Chapter Three details the research design, including the study area, methodology, fieldwork, and data collection and analysis. It features qualitative methods, spatial analysis, and mapping methods to assess land use conflicts and their underlying forces. Chapter Four presents the results, offering insights into Land tuner arrangements, land use conflicts and their drivers, and spatial patterns of conflicts. Key findings from spatial analysis, mapping, and qualitative data are discussed. Chapter Five develops a practical land use conflict resolution model for the communities within the Nanumba South District. It is developed with spatial analysis and community perspectives results, using the Lincoln Institute of Land Policy's framework for integrating mediation into land use decision-making processes. Chapter Six concludes the study by summarizing findings, addressing the research objectives, and providing recommendations for policymakers and future research.

1.8. Chapter Summary

This Chapter provides the background and context of land use conflicts and land use co-existence. It also identifies the research question and includes an argumentation part where the issue focuses on competition for land use between pastoralists and non-pastoralists. The Chapter also describes the research aim and objective of the study. However, the study will focus on how spatial analysis and mapping can help tackle these challenges. Further, it consists of the theoretical background for the research while framing the concept of sustainable goals to contribute to non-violent landscaping and cooperation.

2. LITERATURE REVIEW

This chapter explores the existing literature on land use co-existence, pastoralism, non-pastoralism, land administration, land use conflicts, and conflict hotspot mapping. The review highlights theoretical frameworks and examines case studies relevant to the study.

2.1. Land Use Co-existence

Land use co-existence has become a critical policy focus, particularly in regions where pastoralists and non-pastoralists live together in one community. Ensuring that both groups can sustainably share land resources while maintaining cultural and spatial connectivity presents a unique challenge. The situation becomes more difficult when considering the rising population, the increase in economy-related use, and the culture, religion, or history that makes the land special (Benjaminsen & Ba, 2019; Catley et al., 2013). Ensuring that cultural heritage and sustainable development are sustained remains a complex and important challenge (Flintan, 2011). However, Herrera et al. (2014) state that proper land management for sustainability agrees with using land in a co-existence way, which means pastoralism features different land uses and sharing open resources. This concept is critical as urbanization and agricultural expansion increase competition for finite land resources (Niamir-Fuller et al., 2012).

2.1.1. Cultural and Institutional Dimensions of Land Use Co-existence

For many groups in rural and Indigenous communities, land is not just helpful for farming; it also holds meaning from a cultural, spiritual, and social point of view (Chigbu et al., 2017). Land is essential to pastoral people in East Africa because it supports their mobile lifestyle and is frequently close to conservation lands or farming sites (Scoones, 2020). These overlapping land uses can create friction but highlight the need for flexible, inclusive frameworks that acknowledge cultural values and spatial mobility.

According to Wang et al. (2024), in their research, gave examples from Mongolia to illustrate how localized institutional mechanisms can support land use co-existence, where mobile pastoralists rely on rotational grazing and cooperative agreements to manage shared resources, balancing flexibility with responsibility. Furthermore, these systems, backed by strong social norms and informal institutions, provide adaptive responses to environmental variability and resource pressure. In a study by Galvin et al. (2008), it is stated that dryland communities respond well to the pressures of drought and shortage through successful coordination.

Significantly, co-existence in land use is possible only if cultures adapt and institutions officially agree upon measures. As Herrera et al. (2014) pointed out, for these efforts to succeed, local governance and institutions should ensure shared resources are managed rightly so people can share the area peacefully. Using participatory methods and shared land planning, people can organize their land so that it benefits several activities and helps avoid conflicts. For this reason, it is necessary to fix gaps between institutions and give more power to local people in deciding how land is used (Niamir-Fuller et al., 2012).

2.1.2. Strategies and Solutions for Promoting Co-existence.

Participatory governance can help solve the complexities of sharing land when people such as pastoralists, farmers, and conservationists are involved in the discussion. Using such techniques ensures that power imbalances are dealt with and that generally unrecognized people are part of land use plans (Mwangi &

Ostrom, 2009). Nevertheless, these efforts can only succeed when everyone remains dedicated and there is adequate support from the institutions.

Dynamically shifting how and when stakeholders use land helps them respond to problems that may develop from season to season in the community. In sub-Saharan Africa, joint grazing efforts among communities have cut down conflicts and improved the sustainable use of resources (Benjaminsen & Ba, 2019). Even more, developing infrastructure allows for collaboration and sharing of needed resources. The infrastructure of water downspouts, grazing paths, and transportation systems can limit resource conflicts and help animals depend on each other. These laws must be implemented in the same way so that tensions do not get worse. According to Amanor and Moyo (2008), for infrastructure projects to be successful, they should consider and aid the needs of pastoralists and other vulnerable parties.

2.1.3. Policy Gaps and Challenges

Despite progress in fostering land use co-existence, significant policy gaps persist. Most of these frameworks do not address the cultural, economic, and environmental forces affecting land use. Scoones (2020) points out that these policies focus on quick economic development instead of a future where the environment can be preserved.

Bridging these gaps means incorporating knowledge from the area, being flexible with ways of thinking, and fair policies into making rules. For example, new policies for pastoralist groups should officially protect the freedom of movement they need (Mwangi & Ostrom, 2009). Additionally, more obstacles are seen in issues such as mixed policy plans, weak monitoring, and different levels of resource distribution. Because there are two different land governance systems in Ghana, overlapping interests have reduced land security and led to more land conflicts (Amanor & Moyo, 2008). It is important to focus on areas where governance has failed and make improvements that include everyone and last over time.

2.1.4. Toward a Sustainable Framework for Land Use Co-existence

For land use and its influences not to conflict over time, a complete framework must address cultural, economic, and ecological factors. It is important for the framework to help marginalized groups secure land titles because it supports fairness and avoids conflicts (Mwangi & Ostrom, 2009). Additionally, investments in common infrastructure and processes where people are involved are necessary to promote teamwork and tackle differences in power (Amanor & Moyo, 2008; Scoones, 2020). However, Morton (2007) mentioned that for land use co-existence to work, sustainability in nature, respect for culture, and growing the economy should be brought together. Participatory mapping platforms are tools that increase both transparency and participation in making choices. To sum up, achieving harmony among many ways of using land is more than handling problems; it is building systems so diverse functions can exist together, giving future generations sustainability (Benjaminsen & Ba, 2019; Scoones, 2020).

2.2. Pastoralism and Non-Pastoralism

Pastoralism is a way of life that relies on raising cattle, sheep, and goats across expansive areas. Due to its mobile nature, pastoralism allows people to access the necessary locations for their animals during seasonal changes. However, because pastoralists depend heavily on mobility, they are vulnerable to instabilities such as land use or weather conditions. These challenges often lead to conflicts over land and resources, particularly in regions where pastoralists interact with farmers or people living in communities (Nielsen & Reenberg, 2010; Turner et al., 2012).

2.2.1. Conflicts Between Land Use Systems

Since pastoralists often depend on moving their livestock for pasture, this usually leads to conflicts with people who remain in one location. A movement of pastoralists across vast tracts of land can cause tensions over places to graze, water, and pass through. Conflicts between herders and farmers are made worse in many places in the global South because political issues have historically sidelined pastoralists. For example, policies from Africa's colonial period gave more importance to farming and neglected those who practiced nomadic pastoralism, leading to conflicts now (Benjaminsen & Ba, 2019). Nevertheless, the conflicts between pastoralists and non-pastoralists arise because of their different uses for land. Traditionally, pastoralism features lands owned by groups and focuses on communal movement. Alternatively, farming, private landholdings, and urban areas mostly use land tenure, giving people full and unshared rights to specific parts of land. Such differences cause regular disagreements, as those who are not pastoralists sometimes think pastoralists are taking over their private property (Lengoiboni, 2011).

2.2.2. Development Pressures and Pastoralist Marginalization

Land rights and roles in politics for pastoralists have been reduced as cities expand and new crop farms and real estate developments are built (Turner, 2004; Scoones, 2020). By using these lands, livestock are taking over areas used for grazing and ruining the habitat these animals need to thrive. According to Scoones (2020), land conflict forces pastoralists to leave their areas, leading to more fights between mobile herders and stationary farmers as they need the same resources. Effective management of pastoral lands is also affected by factors like climate instability, the growth of cities, and new trends in the global market for agricultural products (Morton, 2007). The changes result in restricted access to grazing places and a rise in land conflicts.

Generally, ordinary farmers and urban land developers reap the rewards of formal ownership gained from statutory tenure. However, pastoralists depend on traditional arrangements and have common access to places that do not seem official in the national land administration system (Lengoiboni et al., 2011). The differences between law and institutions continue to contribute to the belief that pastoralists are illegal and not welcome by the community. Because of these beliefs, it becomes difficult for non-pastoralists to realize that pastoralism is allowed by law, which worsens exclusion.

Policies that promote intensive farming usually ignore how mobile herders use their lands. In Ghana, many pastoralists have lost access to important grazing lands because the land was acquired for large projects (Kuusaana & Bukari, 2015). Because of this, several governments and international groups have promoted making people more settled to ease conflicts. Some claim that helping pastoralists settle would make it possible to register the land they use and bring them in step with central systems of land usage (Clingendael Institute, 2021). However, the change to ranching makes it less beneficial for the environment and the economy in arid parts of the world, since farming animals in one area does not help manage the limited resources there. For them to get settled often leads to more difficulties for pastoralists because they are forced to rely on poorer farming areas or are kept away from areas they need for their grazing (Turner et al., 2012).

2.2.3. Strategies for Co-existence

Getting pastoralists and non-pastoralists to understand and respect each other helps to solve these challenges. Holding educational campaigns and involving the community in decision-making can correct wrong ideas about pastoralism and ensure fairness in sharing land resources (Catley et al., 2013). Scoones (2020) argues that inclusive decision-making processes involving both groups are essential for reducing

tensions and ensuring fair resource allocation with adaptive strategies, such as zoning for shared land use, which have shown promise in promoting co-existence. These strategies involve designating specific grazing, farming, and conservation areas to minimize conflicts and ensure sustainable resource use. Moreover, Community-led initiatives prioritizing collaboration over competition have also successfully reconciled the differing needs of pastoralist and non-pastoralist groups (Benjaminsen & Ba, 2019). Furthermore, promoting co-existence requires recognizing traditional land rights and developing conflict resolution mechanisms. For example, in Tanzania, integrated land use planning has successfully addressed the needs of both pastoral and agricultural communities, reduced conflicts, and fostered mutual benefits (Mwangi & Ostrom, 2009).

2.2.4. Bridging Pastoral and Non-Pastoral Land Use Systems

Resolving the tensions between pastoralism and non-pastoralism requires a shift toward more inclusive land use policies that support coexistence rather than competition. These tensions are often rooted in conflicting land claims, legal pluralism, and the undervaluing of mobile livelihoods in national land systems (Behnke, 2008; Scoones, 2020). Formalizing the land rights of pastoralists while maintaining the flexibility needed for mobility is essential to addressing historical inequities and reducing conflict. Policies that recognize the ecological contributions of pastoralism and integrate them into national development planning can help bridge the divide between competing land use systems (Scoones, 2020). Governments can foster conditions where both systems operate productively by promoting mutual recognition of land use rights, sustainable practices, and participatory decision-making. Furthermore, equitable policies must address entrenched power imbalances and ensure that pastoral and agricultural systems are fairly represented in land-related decisions. Hybrid models that combine customary and statutory approaches offer a viable path forward, as illustrated by Ghana's land administration reforms (Amanor & Moyo, 2008).

2.3. Land Administration

According to the United Nations Committee of Experts on Global Geospatial Information Management (2020), "Land administration is described as the process of determining, recording, disseminating, and updating information about the relationship between people and land" (p. 11). With these frameworks in place, land resources are managed efficiently and fairly, as the documents they provide outline ownership, the land's value, and how it is utilized (Schmidt & Pearson, 2016; Lengoiboni, 2011). Nevertheless, in numerous situations, current arrangements primarily support fixed land use by overlooking the needs of mobile and group land users, particularly those from pastoralist communities, and examining the behaviour and interaction between pastoralists and non-pastoralists influences how land is used in communities (Lengoiboni et al., 2011).

2.3.1. Challenges in Addressing Diverse Land Use Practices

According to Lengoiboni (2011), the land administration sector faces challenges due to its failure to incorporate various land use patterns. In African societies, community members rely on customary land tenure rules that emphasize teamwork and equitable access to land. These rules significantly influence the sharing of land between farmers and pastoralists. However, because property rights are often unrecognized, these groups frequently lose their land to authorities. Statutory frameworks that prioritize fixed ownership and boundaries often conflict with the communal and mobile nature of pastoralist land use. Farming communities may view grazing land as "dead capital," which further complicates relationships (Robinson & Flintan, 2022). Harmonizing customary and statutory systems is essential for addressing these issues and promoting co-existence in land use.

Moreover, people from marginalized groups have to face the effects of governance challenges more than others. Women, youth, and pastoralists are often left out of decisions when there are differences in influence between local leaders, officials, and actors from other countries. Companies obtaining land and projects backed by the government weaken traditional government systems (Wily, 2011). It is challenging for pastoralists to maintain continuous rights to use certain lands because of the way they move around. These issues are important, which means that they should be handled to ensure equal rights and fair land distribution (Adomako, 2019).

2.3.2. Engaging Local Communities in Decision-Making

Allowing local groups to take part in regulating their lands promotes social equality and teamwork. Historically, traditional leaders such as chiefs and elders have cared for the land, and people shared and settled conflicts (Arko-Adjei et al., 2010). However, they face more challenges as a result of efforts by the government and pressures from outside, such as companies acquiring land and urban growth. Participatory governance models should offer a solution by integrating local knowledge with formal systems (Ribot, 2002). For instance, Brown & Raymond (2013) highlight how participatory mapping has successfully mediated conflicts by addressing local resource conflicts and enhancing stakeholder collaboration.

In Ghana, forming local land committees has helped to solve land conflicts in communities. Working with chiefs and community leaders in the Upper East Region has helped map out pastoral areas, lowering stress between pastoralists and farmers (Adomako, 2019).

2.3.3. Integrating Customary and Statutory Land Tenure Systems

Participatory approaches, such as community-led mapping exercises, bridge the gap between customary and statutory land tenure systems. Mapping pastoralist migration routes has reduced conflicts in parts of East Africa (Eilola et al., 2021). Additionally, recording communal grazing areas has given traditional farming communities a way to recognize pastoralists by law and encouraged people involved to work together. For instance, in Kenya, opening up designated corridors through a team-based GIS system has led to a significant reduction in conflict, since it marks areas clearly for both farmers and herders, fostering mutual respect among people involved (Lengoiboni, 2011). These methods explain the need to blend old and new ways of governing land to guarantee sustainability (African Union, 2010).

Ghana provides notable examples of incorporating traditional and formal laws by introducing organizations such as the Customary Land Secretariat (CLS). In regions like the Northern Region, these secretariats seek to set out land rights while respecting how land is held under customary laws. CLS has minimized conflicts and clarified things by granting customary rights the same legal status as laws (Adomako, 2019).

2.3.4. Tenure Arrangements and Land Use Conflicts

Land tenure arrangements are central to understanding land use conflicts in regions like Nanumba South, where pastoralist and farming communities rely on different land access and control systems. In many parts of Ghana, land is governed by a dual system, customary and statutory, leading to overlapping claims and legal uncertainty (Kuusaana & Bukari, 2015; Amanor & Moyo, 2008). While farmers often enjoy relatively secure rights through customary lineage, pastoralists usually access land via informal or seasonal agreements, which lack legal recognition and are prone to contestation (Bukari & Kuusaana, 2018). These divergent tenure systems contribute significantly to misunderstandings and conflicts. As Lengoiboni (2011) notes, the statutory framework prioritizes fixed, individual land ownership, which clashes with the communal and

mobile land use patterns characteristic of pastoralist livelihoods. This legal mismatch undermines pastoralist land claims and weakens their position in conflict resolution and land-use planning processes.

Furthermore, the increasing commodification of land has led to converting communal grazing lands into farms or private holdings, further marginalizing mobile users (Turner, 2004; Scoones, 2020). In Nanumba South, chiefs and family leaders act as custodians of land under customary arrangements but often lack precise mechanisms to reconcile competing claims from transient pastoralists and sedentary farmers, leading to inconsistencies in land allocation (Adomako, 2019). This uneven tenure landscape also limits implementing inclusive planning and conflict mitigation tools. Without formal recognition of pastoral land rights, efforts such as participatory mapping or zoning may fail to provide lasting solutions. As Robinson and Flintan (2022) argue, formalizing communal tenure, especially for pastoralists, is critical to achieving equitable land access and reducing tensions.

2.3.5. Role of Technology in Enhancing Land Administration

Advances in GIS and blockchain technologies have significantly changed land administration. Using GIS mapping, researchers can mark important areas of conflict and find out what resources are available, which makes it easier for partners to respond together (Lengoiboni, 2011). Using GIS in northern Ghana, it has been possible to map and describe grazing areas and crop zones, which decreased conflicts and promoted collective action (Adomako, 2019). GIS helped assure communal rights to land, develop trust between stakeholders, and cut down on conflicts in Tanzania (Eilola et al., 2021). Using blockchain, land transactions can be safely recorded because the platform cannot be altered and ensures that all claims are handled by the law.

2.3.6. Toward Inclusive and Sustainable Land Administration

Achieving inclusive and sustainable land administration requires harmonizing customary and statutory systems to reflect the needs of diverse land users with formalizing customary land rights, particularly for pastoralist communities, which can reduce vulnerabilities and conflicts by legally recognizing communal practices and ensuring access to critical resources (Robinson & Flintan, 2022). This process minimizes conflicts over land boundaries and improves clarity, as demonstrated in cases where participatory mapping has helped define rights and responsibilities (Robinson & Flintan, 2022). Mapping grazing routes and communal boundaries provides a practical means of integrating customary land use into statutory systems. National administrations should prioritize the formal recognition of communal tenure and ensure that pastoralist land use is appropriately documented within national land registries and planning frameworks (Robinson & Flintan, 2022). This includes safeguarding migration corridors, investing in shared infrastructure, and adapting administrative tools to accommodate pastoral mobility.

Gender considerations must also be embedded within land administration processes. For instance, reforms mandating joint land registration for married couples in Rwanda have significantly improved women's land ownership and legal recognition, demonstrating the importance of inclusive administrative policy (Bayisenge, 2018). Investments in capacity-building, land information systems, and documentation processes are essential to building systems that are transparent, inclusive, and conflict-sensitive. In Tanzania, local-level programs have empowered communities to participate in land registration efforts, and participatory mapping has been used to document communal resources, helping reduce conflicts and build trust among users (Eilola et al., 2021).

2.4. Land Use Conflict

Land use conflicts arise because land is scarce, and regular conflicts exist between various groups, especially pastoralist groups and farmers. Such conflicts appear in areas often shared by people with different ways of living, for instance, showing problems with governance, shortages of important resources, and economic gaps. Benjaminsen and Ba (2019) noted that these conflicts result from significant defects in land governance systems and how people use land.

2.4.1. Drivers of Land Use Conflicts

Land use disagreements leading to conflicts are driven mainly by several factors, and population increase is a contributing factor. Maja and Ayano (2021) state that when land gets more crowded, there is increased competition. The increase in cities and farming activities often takes over grazing areas, pushing pastoralist communities away and affecting their way of living. However, such problems make it clear that the current spatial planning system cannot address the problems caused by various groups wanting to use the same areas, but it adds to the tensions.

Climate change worsens things by reducing and changing how resources are spread worldwide. For example, Benjaminsen et al. (2012) argue that reducing rain or droughts continues to force pastoralist populations to seek different resources through migration. Additionally, there are conflicts between pastoralists and farmers, since animals from the herds can damage farm crops. It highlights how pastoralist systems are affected by weather changes and shows that the present government approaches are not sufficient for dealing with these matters. Conflicts can be made worse by unclear land tenure systems. Because both customary and statutory systems are used, it becomes unclear who has the right to use the land. Traditional and formal ways of using land continue to spark conflicts between those who follow pastoralist traditions and agricultural practice in Ghana (Bukari & Kuusaana, 2018). Combining customary and statutory approaches to deal with these gaps is important to ensure fair land use and lessen conflicts.

Even though resource shortage is a key cause, the unequal distribution of power and wealth is another important reason behind land use conflicts. A common theme in the literature is that pastoralists do not play an important role in government and decision-making. Limited help and support from law and institutions causes pastoralists to experience more prejudices and incidences of violence, the study by Adomako (2019) suggests. Ajala (2021) also reports that ethnic and religious identities have made land conflicts in Nigeria's Middle Belt push towards identity-based conflict.

2.4.2. Strategies for Conflict Resolution

Resolving land use conflicts requires integrated legal and community-based approaches. Lengoiboni et al. (2010) highlight the importance of clarifying land tenure through reforms and documenting pastoralist migration routes. Formal recognition of grazing corridors and seasonal access rights can reduce uncertainty and minimize friction. According to Benjaminsen and Ba (2019), Community-led mechanisms also play a central role, with a well-documented approach to how dialogue forums and mediation committees improve communication between user groups, build trust, and create locally legitimate solutions. These platforms support negotiated outcomes that balance competing claims and respect local norms. Finally, conflict resolution must address both practical access issues and structural inequality. This means ensuring that land security is improved, everyone can take part fairly in land matters, and the rights of pastoralists are acknowledged.

Alternative Dispute Resolution (ADR) has gained importance in solving land disputes in Ghana, especially if the traditional courts are too far or thought to be biased. The passage of the Alternative Dispute

Resolution Act, 2010 (Act 798) ensured that mediation, negotiation, and arbitration were accepted ways to settle disputes or conflicts in various sectors, such as land administration. Because Ghana's law draws from both written and traditional laws, ADR supports efforts to ease conflicts in situations where regular court trials might not work well. According to Ibrahim et al. (2022), ADR is becoming more popular in rural and peri-urban areas because it acts faster and provides more suitable results in shared claims and boundary disputes. Nevertheless, many pastoralist and farming communities do not fully understand ADR, which makes adopting it more difficult. However, entities such as the Lands Commission have included ADR skills training and community liaison among their main aims for land conflict resolution (Lands Commission, 2024). Although these steps are important, research suggests that extra efforts in education and awareness are required to improve trust in ADR processes (Ibrahim et al., 2022). Including ADR in the overall regulation of land at the district level creates new chances for local communities to settle disputes and complement existing formats

2.4.3. Participatory Mapping in Conflict Resolution

Solving land use conflicts calls for methods where all affected parties are involved in making decisions. They focus on people working together, having discussions, and respecting each other, making it possible to achieve sustainable results. If pastoralists, non-pastoralists, and local authorities are included, everyone can contribute their views, as Abubakari et al. (2020) suggested. Participatory mapping leads to good results in resolving conflicts over land use since it ensures that solutions are developed by those involved and lets everyone understand the problems using the same picture. A good example is East Africa, where specific maps made by local communities have assisted in finding areas where both groups can use the same land without harming one another (Smith et al., 2000).

When people are involved in making choices, fair agreements can be made that reduce frequent conflict incidents. Forums for dialogue and mediation committees have become important parts of participatory frameworks. These forums enable stakeholders to share their worries, ask for what they need, and come to agreements that suit everyone. Examples can be made of community mediation programs in Ghana that have helped farmers and pastoralists settle their conflicts by bringing them together and encouraging them to agree. They point to the important role of such frameworks in ensuring justice and sustainability (Adomako, 2019).

2.5. Conflict Hotspot Mapping

Conventional conflict mapping often depends on traditional surveys and remote sensing techniques. Even though these devices show the places of struggle for limited resources, they often miss the deeper reasons for fighting and do not include the firsthand stories of local people. For instance, Miller (2015) claims these methods do not consider the changing and spatially varying way resources are used, especially in pastoralism. In addition, these methods could strengthen the power of those already in charge because marginalized stakeholders are not included in the mapping.

As Redpath et al. (2013) observe, hotspot mapping alone can only deal with technical aspects and little else. Maps with only economic and demographic data are insufficient for good sustainability plans. As a result, it shows that making use of all stakeholders' knowledge and ideas is important for resolving conflicts in a way that is both sustainable and fair.

2.5.1. Challenges in Participatory Frameworks Implementation

Even though participatory frameworks bring significant benefits, implementing them is still very challenging. Inclusivity may be disrupted if stakeholders have unequal powers (Ajala, 2021). This way, pastoralists outnumbered by developers and large farmers may find it hard to be heard in such talks. According to Turner (2004), participatory frameworks should focus on helping marginalized people increase their abilities.

Training programs, leadership development, and legal literacy efforts can empower marginalized groups to engage effectively in decision-making processes (Ajala, 2021). Additionally, neutral facilitators can strive to create balance among community members and help everyone speak up. Dealing with such issues helps participatory frameworks reach their maximum potential in settling issues related to land usage.

2.5.2. Mechanisms of Participatory Frameworks

Participatory frameworks are dialogues between key players, mapping the community, and resolving conflicts. In the northern region of Ghana, local councils use group activities to address and settle problems between pastoralists and farmers. Seasonal agreements worked out by traditional leaders in Mali have succeeded in managing resources and show little tension between the farmers and the pastoralists (Umutoni & Ayantunde, 2018; Adomako, 2019).

2.5.3. Case Studies in Participatory Conflict Resolution

In West Africa, several case studies demonstrate that taking part in decisions improves education. Traditional leaders in the Upper East Region have helped Ghanaian communities sort out conflicts by clearly dividing grazing areas for pastoralists and sedentary farmers. At the same time, in Niger and Burkina Faso, participatory mapping helped form village committees that settled issues related to shared water and grazing land, resulting in less conflict in regions with not enough resources (Damiba et al., 2016; Adomako, 2019).

2.5.4. Evaluating the Effectiveness of Participatory Approaches

The effectiveness of participatory frameworks can be evaluated using metrics such as conflict resolution rates, stakeholder satisfaction, and the durability of agreements. For instance, a study in Ethiopia applied these metrics to assess the outcomes of community-led grazing management initiatives, finding that such frameworks increased stakeholder trust and reduced conflicts over resource allocation (Schmidt & Pearson, 2016). In Ghana, participatory GIS mapping projects, such as those implemented in the Northern Region by the Customary Land Secretariat, have clarified boundaries and resource allocation, reducing land conflicts (Adomako, 2019). Similarly, in Tanzania, stakeholder surveys revealed increased trust and collaboration following the implementation of participatory resource management committees to mediate conflicts between farming and pastoralist communities (Eilola et al., 2021).

2.5.5. Lessons Learned from Participatory Frameworks

Lessons from participatory frameworks emphasize inclusivity, capacity-building, and adaptability. Empowering marginalized groups through training and leadership development has ensured equitable participation. Take Kenya, for example; by focusing on leadership development for pastoralist women, the government has increased their chances of involvement in local decision-making (Yiampoi, 2014). For instance, building the negotiation skills of community leaders in Nigeria led to equal results in disagreements about land. Moreover, independent facilitators have balanced power relationships and helped make decisions fairer (Ajala, 2021). They showed that it is important to keep improving participatory tools because land-use challenges keep changing.

2.6. Chapter Summary

This chapter explores the literature on land use co-existence, pastoralism, non-pastoralism, land administration, land use conflicts, and conflict hotspot mapping. Key challenges include overlapping land claims, marginalization of pastoralist communities, and inconsistent policies. Solutions discussed include integrated land-use planning, formalizing customary land rights, and leveraging tools such as participatory mapping to clarify boundaries and reduce conflicts. The chapter emphasizes the need for frameworks that balance cultural, economic, and ecological priorities.

3. METHODOLOGY

3.1. Study area

Nanumba South District, situated in the Northern Region of Ghana, has Wulensi as its administrative capital. Geographically, the district lies between latitudes 8°30'N and 9°25'N and longitudes 0°57'W and 0°15'W, and it covers a total land area of approximately 1,789 square kilometres (GSS, 2021). It shares boundaries with Nanumba North Municipal to the north, Kpandai District to the east, East Gonja District to the west, and Nkwanta North District of the Oti Region to the south. According to the 2021 Population and Housing Census, the district has a total population of 106,374, with agriculture being the primary economic activity (GSS, 2021). The area is predominantly rural, with most residents engaged in crop cultivation and livestock rearing (MoFA, 2021). The district's terrain is marked by savannah grasslands interspersed with shrubs, small hills, and riverine ecosystems. The Oti River and its tributaries are important water sources for irrigation and livestock, especially during the dry season. Nanumba South experiences a tropical climate characterized by distinct wet (May to October) and dry (November to April) seasons, with an average annual rainfall of approximately 1,100 mm, conditions that are favourable for both farming and animal husbandry (GMet, 2023).

Due to its socio-economic, geophysical, and environmental attributes, the Nanumba South District is particularly well-suited for investigating land use issues and interactions between pastoral and non-pastoral populations. The district is a bimodal system where local crop farmers and transhumant pastoralists, such as the Fulani, graze their herds and seek water and grazing resources. Crop farming is the country's most dominant type of farming, with products including yam, maize, cassava, and groundnuts. Livestock farming encompasses cattle rearing, sheep rearing, and goat rearing. These include frequent land use for farming and grazing, often leading to conflicts over common land (Kuusaana & Bukari, 2015). These conflicts are, however, compounded by the customary land tenure system, where the chiefs and other local authorities dispose of the land. The lack of well-defined property rights and overlapping tenure systems is integral to the conflict between the two groups, particularly regarding access to resources.

As outlined in this study's problem statement (Section 1.2), the Nanumba South District exemplifies the tensions between traditional pastoralist practices and expanding agricultural demands, a conflict pattern extensively documented by Kuusaana and Bukari (2015), who highlight the unique challenges posed by overlapping land tenure systems in Ghana's northern regions. In recent years, the Nanumba South District has experienced various forms of land use conflicts, primarily due to cattle grazing on farms and the conversion of grazing zones into farmland. These tensions have significant socio-economic impacts, as changes in land use for productive purposes affect communities' food security and income sources (Maasole, 2011).

Figure 2 provides the geographic layout of Nanumba South District in the Northern Region of Ghana. The map shows key communities, including Lungni, Kanjo, and Gbungbaliga, the three selected field sites for this study. While other settlements such as Nakpayili, Wulensi, Kumanie, Montanaya, and Tampoaya appear on the map, they were not included in the fieldwork and are shown solely to provide a comprehensive spatial context of the district.

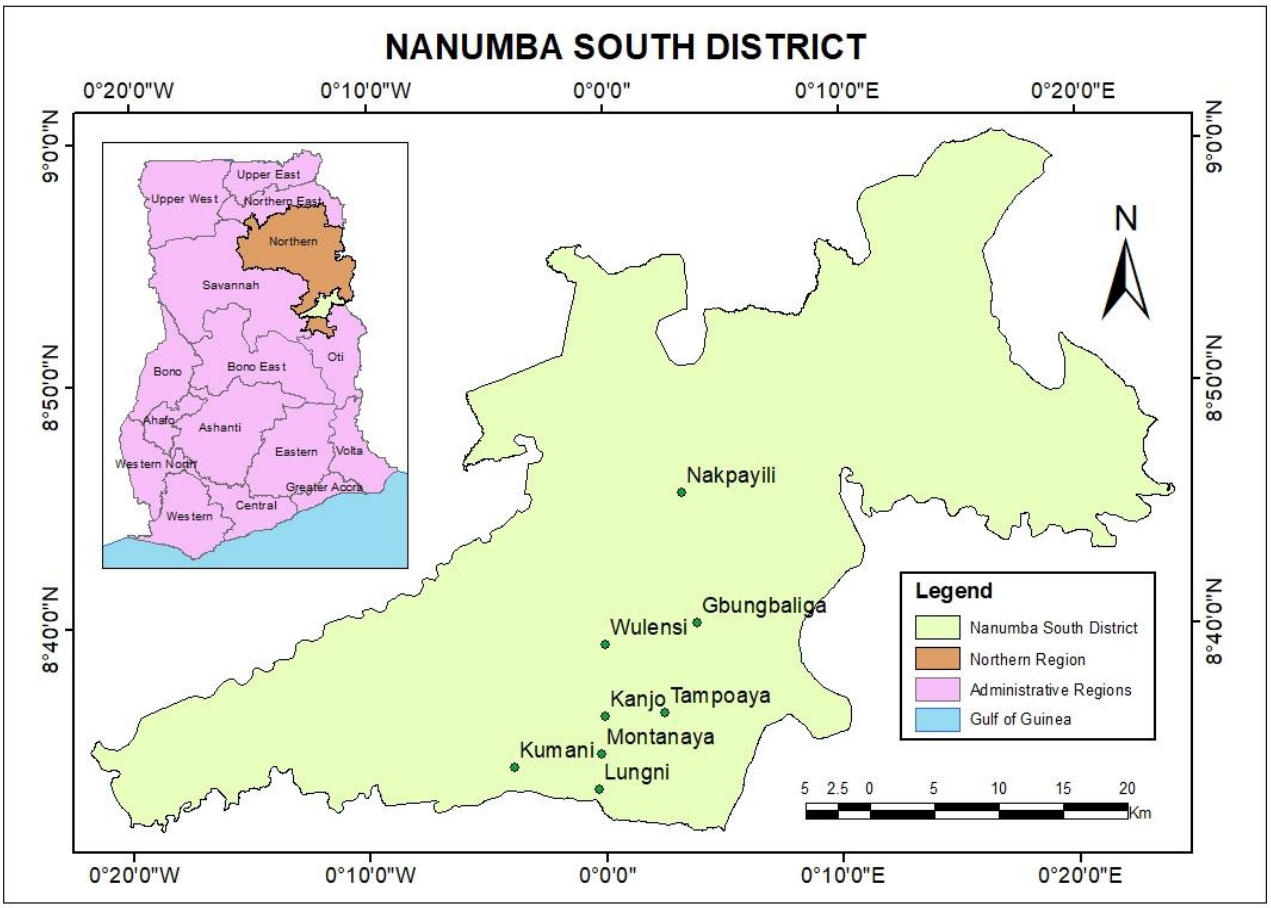

Figure 2: Study Area Map showing the three locations, Kanjo, Lungni, and Gbungbaliga, of field work

3.2. Methodological workflow

This study followed a structured, multi-stage workflow designed to address land use conflict through qualitative and spatial lenses. The process began with a combined policy and literature review to establish a conceptual and empirical foundation. The policy review examined the legal frameworks and institutional arrangements that influence land administration, while the literature review identified research gaps and guided the formulation of research questions. Together, these reviews informed the selection of methods and the framing of analytical priorities. The qualitative phase examined the socio-cultural and institutional dimensions of land use conflict. Drawing on data collected through interviews and focus group discussions, thematic analysis was conducted to identify patterns related to land tenure, conflict drivers, and local resolution practices. This stage provided a grounded understanding of how different actors experience and interpret land use pressures.

To complement these findings, spatial analysis was carried out using participatory mapping and satellite imagery. This phase involved land cover classification and overlay techniques to identify conflict hotspots where land uses such as grazing, farming, and settlement intersect. Community involvement in mapping ensured that the spatial data accurately reflected local realities, thereby strengthening the validity of the analysis.

Finally, insights from both qualitative and spatial components were synthesized to develop a practical model for resolving land use conflicts and improving the co-existence of land use. This model integrates stakeholder perspectives with spatial evidence to offer context-specific conflict resolution and land management strategies. The workflow, as shown in Figure 3, concludes with policy recommendations promoting sustainable and equitable land use for improved livelihoods for the communities.

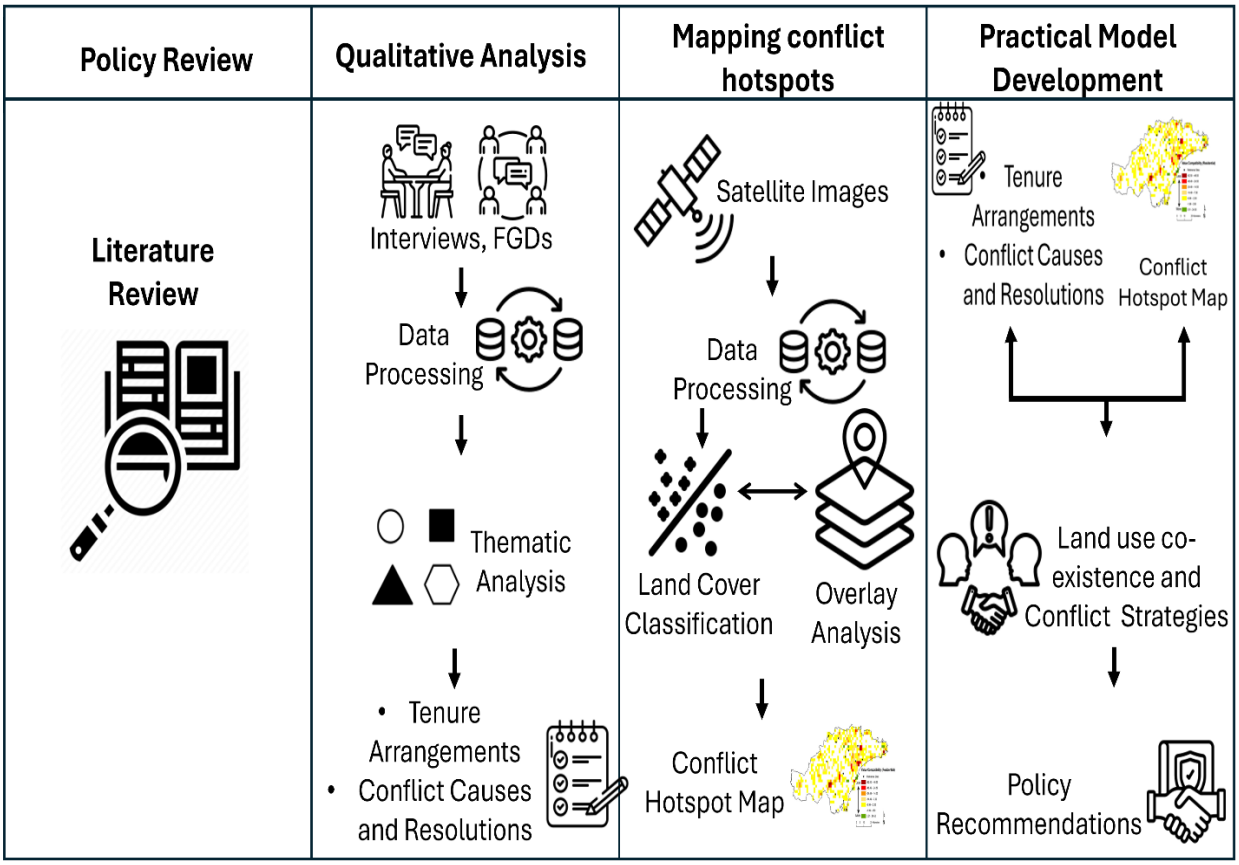

Figure 3: Methodology Workflow with the different steps followed, starting from left to right

3.3. Research Approach

This study employed a mixed-method approach to address the unique knowledge gaps identified in the background. Through semi-structured interviews and focus group discussions, the research explored the cultural, social, and traditional aspects of land administration and land use conflicts documented in the literature. These qualitative methods provided an in-depth understanding of the nature of land tenure arrangements for pastoralist and non-pastoralist populations and the drivers and patterns of conflict. Complementing this, the analysis of land cover data from the Esri database provided a spatial representation with conflict hotspots and cattle routes, directly addressing the spatial analysis gap outlined and justified (sections 1.2 and 1.3). Integrating qualitative narratives with spatial data validated participant insights, providing a comprehensive view of land-use interactions in the Nanumba South District. This combination contributed to the study's relevance and accuracy (Lee, 2019; Denscombe, 2017).

3.4. Data collection

Data collection for this study was conducted in three key communities within the Nanumba South District: Lungni, Kanjo, and Gbungbaliga. These communities were selected due to their significant involvement in farming and pastoral activities, which represent the district's primary land-use practices. Their inclusion

ensured that the research captured diverse perspectives on land tenure arrangements, the drivers of land use conflicts, and the mitigation and environmental dynamics that shape these interactions.

Figure 4 shows images taken during data collection with participants during interviews, FGDs, and participatory mapping.

Figure 4: Images from Data Collection activities across selected communities in the Nanumba South District

Figure 4 presents qualitative data collection activities across the three study communities: Lungni, Kanjo, and Gbungbaliga. It includes focus group discussions (Figures A and B), participatory mapping sessions (Figures C, E, and F), and key informant interviews (Figure D). These visuals highlight the participatory and locally grounded approach to capturing spatial knowledge and community perspectives on land use conflict.

3.4.1. Key Informant Interviews

As part of the qualitative data collection process, semi-structured interviews were held with a diverse group of stakeholders, including farmers, cattle owners, police officers, Lands Commission staff, assembly members, and family heads. These individuals were purposively selected based on their direct engagement with land-related issues and their roles in community-level governance, conflict resolution, or land administration. The interviews were guided by themes such as land tenure arrangements, land use practices, conflict triggers, and institutional roles. Each session lasted approximately 60 minutes and was conducted in the participants' preferred language to ensure clarity, accuracy, and cultural sensitivity.

A semi-structured interview format was employed to ensure consistency across interviews while allowing flexibility to explore emerging themes and adapt to each participant's unique knowledge and experiences. As detailed in Appendix 3, the interview guide includes indexed questions used during data collection. This approach enabled the researcher to maintain thematic direction while remaining responsive to the dynamics of individual conversations, one of the recognized strengths of semi-structured interviews (Denscombe, 2017). This method helped gather detailed, first-hand perspectives on the practices and challenges surrounding land use in the study communities.

Table 1 presents the categories of key stakeholders who participated in the semi-structured interviews conducted across the three study communities. A total of 26 individuals granted the interviews, offering diverse perspectives on land tenure, access, and conflict management.

Table 1: Summary of Interviewed Participants for

Stakeholder Group	Specific Individual	Number of Participants
Farmers	Local farmers in the communities	7
Cattle owners	Resident cattle owners	6
Traditional leaders	Family heads in the communities	6
Government officials	Lands Commission staff	3
The police	District police commander	1
Community leaders	Assemblymen	3

Source: Field study 2015

3.4.2. Focus Group Discussions

Focus Group Discussions (FGDs) were conducted in the three selected communities, Kanjo, Lungni, and Gbungbaliga, to explore local perspectives on land use and conflict. In total, six FGDs were organized: three with only pastoralists and three with mixed groups that brought together farmers, herders, local leaders, and other community members, including women. The pastoralist-only sessions each involved three participants, mostly male herders between the ages of 25 and 50, who had lived in the communities for several years and were actively involved in livestock keeping. These discussions allowed for open conversations about seasonal movements, access to grazing land, and how herders interact with crop farmers in daily life.

The groups included men and women across different age brackets, from younger adults to elders. They represented a variety of roles in the community, such as farming, herding, household leadership, and community leadership. Bringing these diverse voices together created space for open dialogue on sensitive issues like land competition, shared resource use, and the ways people negotiate or avoid conflict. Each session lasted about 50 minutes, offering rich, grounded insights that complemented the key informant interviews and supported the spatial analysis by adding local experiences and context.

Table 2 presents the composition and distribution of Focus Group Discussions (FGDs) conducted across the three study communities. A total of six FGDs were held: three with only pastoralists and three with mixed groups. The pastoralist-only FGDs were smaller in size to allow for deeper engagement, while the mixed-group sessions were larger and intended to capture a range of perspectives on land use, resource sharing, and community-level conflict dynamics.

Table 2: Summary of Focus Group Discussions (FDGs) Conducted in all three communities.

Focus Group Discussions (FGDs)	Number of Discussants	Location
FGDs with pastoralists	3	Kanjo
FGDs with pastoralists	3	Lungni
FGDs with pastoralists	3	Gbungbaliga
FDGs with all groups	15	Kanjo
FDGs with all groups	14	Gbungbaliga
FDGs with all groups	12	Lungni

Source: Field study 2015

3.4.3. Participatory Mapping for Spatial Data Collection

Participatory mapping was conducted in the three study communities using printed satellite images as a base. Community members, including elders, herders, and farmers, marked cattle routes, grazing zones, water points, and conflict-prone locations directly on the maps. This hands-on method allowed for the spatial referencing of extensive local knowledge and helped align verbal narratives with observable land-use patterns. The sessions encouraged collaborative reflection and provided a platform for participants to articulate spatial constraints related to mobility, seasonal use, and land claims (Silverman & Patterson, 2021; Ahmad & Wilkins, 2025). The marked maps were then scanned, digitized, and georeferenced using ArcGIS version 10.8.2, following standard GIS procedures for converting analog maps into geospatially accurate formats (ESRI, 2020). This process aligned with participatory GIS practices that emphasize integrating community-generated spatial knowledge into formal mapping environments (Brown & Kyttä, 2014).

3.5. Qualitative Content Analysis

This study employed content analysis to examine qualitative data collected through interviews and focus group discussions conducted in Lungni, Kanjo, and Gbungbaliga. Content analysis was selected for its ability to systematically identify, categorize, and interpret themes and patterns within large volumes of text. To support this process, the qualitative data analysis software ATLAS.ti was used. All interview transcripts and participatory discussion notes collected from farmers, pastoralists, traditional authorities, local government officials, and other community stakeholders were transcribed using TurboScribe tools and imported into ATLAS.ti (version 25.0.1.32924) for qualitative analysis. A thematic coding framework was developed based on deductive categories informed by the research questions (e.g., land access, conflict triggers, tenure arrangements) and inductive themes emerging from the data. ATLAS.ti was used to code, categorize, and analyze patterns across stakeholder groups, enabling comparison of perceptions and conflict narratives across social roles and geographic zones. The software's query and co-occurrence tools facilitated the identification of frequently linked themes, such as the overlap of cattle movement with farmland access or traditional versus formal conflict resolution. This systematic approach ensured that the voices of all actors were analysed and directly informed the structure and logic of the land use co-existence model.

In addition to thematic analysis, basic quantification techniques were employed. The number of respondents referencing particular concepts was tallied, and the proportion of respondents mentioning each theme was

calculated. This provided a clearer sense of the relative salience of each issue across the dataset and added a quantitative dimension to the qualitative findings.

3.6. GIS-Based Quantitative Analysis

The quantitative aspect of this research, the spatial component, utilized GIS techniques to identify zones of potential land-use conflict and resource competition. Land cover data were sourced from the European Space Agency (ESA) World Cover 2021 product as a secondary data source for land cover classification (European Space Agency, 2021). The map has a spatial resolution of 10 m and is produced using a Random Forest classification model trained on Sentinel-1 and Sentinel-2 imagery (Zanaga et al., 2022). The LULC data provided a standardized base layer with different classes, such as agricultural areas, settlements, vegetation cover, and water bodies. The overall accuracy of the ESA WorldCover 2021 dataset is reported at 83.8% ± 0.4%, making it suitable for regional land cover classification and spatial analysis. The dataset is publicly available at: https://esa-worldcover.org/en.

High-resolution base maps such as Google Satellite imagery (5 cm per pixel) were also used for qualitative cross-validation and contextual interpretation. However, no pixel-level comparison was performed due to a significant mismatch in spatial resolution. As roughly 40,000 5 cm pixels can fit within a 10 m pixel, any direct spatial overlay would introduce scale-based error and misrepresent classification performance (Pontius & Cheuk, 2006; Pontius & Clark, 2007). Instead, the analysis relied on thematic validation at a landscape unit level, following a best-practice approach for large-scale land cover datasets. This aligns with current frameworks for operational validation of Global Land Cover (GLC) maps, emphasizing aggregation and stratified sampling over direct pixel matching (Tsendbazar et al., 2021).

Printed Google Satellite imagery was used in participatory mapping sessions, where community members marked cattle routes, grazing areas, and conflict hotspots directly on the maps. These annotated paper maps were later scanned and digitized using ArcGIS, allowing the integration of local knowledge into a spatial format. The digitized outputs served as the basis for overlay analysis to assess the spatial intersection of community-identified routes and conflict zones. Land cover data from the ESA WorldCover 2021 product, classified using 2021 Sentinel imagery, were used primarily to cross-validate the local mapping outputs (European Space Agency, 2021). GIS tools such as buffer analysis were applied to determine the proximity of cattle corridors to farmlands and settlements. Additionally, hotspot mapping was conducted to identify statistically significant clusters of spatial conflict events (Goodchild, 2007; Walther et al., 2023). All spatial layers were processed and visualized in ArcGIS, using the GCS_WGS_1984 geographic coordinate system (EPSG:4326).

The choice of a 100-meter buffer for cattle routes and a 50-meter buffer for conflict hotspots was informed by both GIS best practices and empirical observations during the fieldwork. A 100-meter buffer around cattle routes was applied to capture the typical interaction zone between livestock movement and adjacent land uses such as farms, settlements, and water sources. While no fixed national standard defines this distance, participatory mapping sessions and local testimonies consistently highlighted that such interactions frequently occurred within this range. This selection aligns with spatial analysis conventions for linear features, as the ArcGIS documentation recommends (Esri, 2024). In rural Ghanaian settings, especially under customary tenure systems, land parcels are often informally demarcated and small in size, which increases the likelihood of overlap between mobile herders and stationary land users (Nara et al., 2021). Rather than relying on assumptions, the 100-meter threshold was determined as a practical balance between analytical relevance and on-the-ground realities reported by community members.

A 50-meter buffer was employed for conflict hotspots to allow for a more localized and granular analysis of areas where tensions are concentrated. This narrower zone effectively spatially isolates conflicts around boundary zones, contested land parcels, or limited access points. These distances are not arbitrarily chosen but are supported by the dual pillars of field-based input and spatial analysis standards, making them both defensible and context-specific. Additionally, the approach reflects broader national practices, such as Ghana's Riparian Buffer Zone Policy, which advocates using setback zones to manage land-use overlaps and ecological pressures (EPA Ghana, 2011). These spatial thresholds provide a technically sound and socially grounded method for analyzing land use conflict dynamics.

To validate the outputs, the GIS results were cross-referenced with qualitative data from interviews and focus group discussions. For instance, reported bottlenecks, unauthorized grazing paths, and restricted water access were spatially verified against GIS-identified high-pressure zones. This integration strengthened the reliability of the analysis by grounding abstract spatial data in lived community experience.

3.7. Development of a Practical Model

The land use co-existence model was developed through an iterative process that integrated qualitative insights from interviews and participatory mapping with quantitative spatial analysis. Data were collected through semi-structured interviews, participatory mapping, and field observations to capture land use patterns, cattle routes, conflict hotspots, and traditional tenure and conflict resolution mechanisms. These qualitative insights were spatially validated using GIS techniques such as buffer analysis and hotspot mapping to assess interactions between cattle routes and surrounding land uses. Community-based conflict resolution practices shaped the structure of the model (Agegnehu et al., 2021) and adaptive mediation frameworks (Lincoln Institute of Land Policy, 2010), both of which emphasize the integration of traditional and formal systems in land conflict management. This methodology ensured that the resulting model was empirically grounded and locally adaptable. Figure 5 illustrates how different data inputs are synthesized into a flexible, community-centred land use co-existence model.

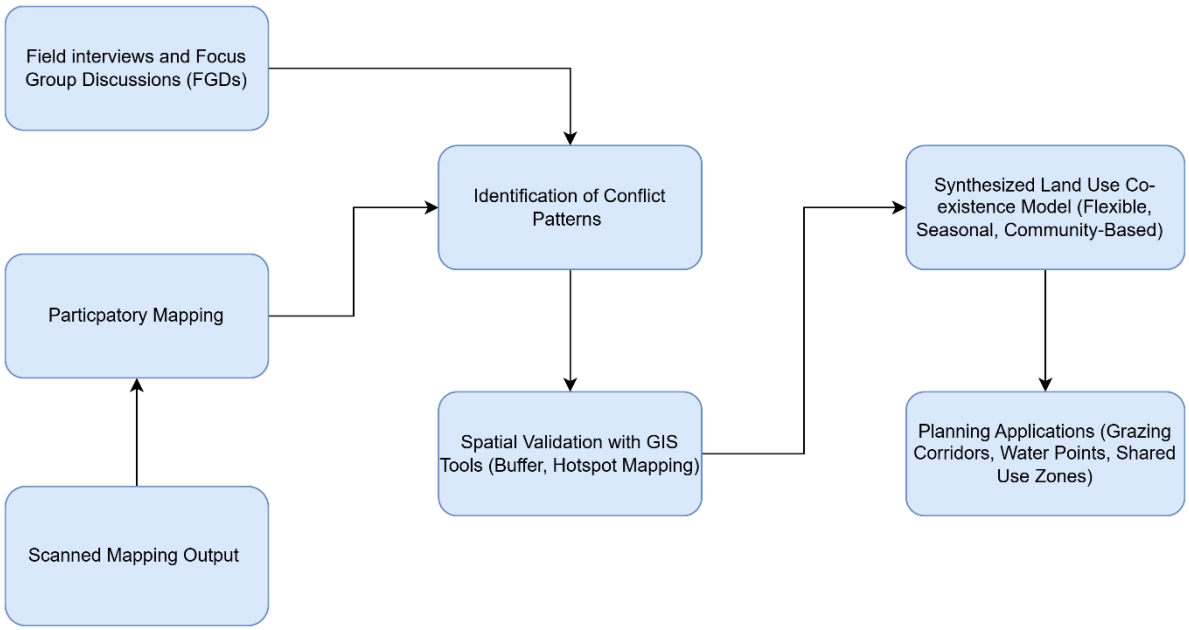

Figure 5: Conceptual Framework for Developing Land Use Co-Existence Model.

3.7.1. Policy Recommendations and Community Guidelines

Rather than ending with a theoretical model, the research aimed to translate insights into tangible solutions for land use co-existence. Building on the land use conflict resolution model developed through community engagement and spatial analysis, a set of policy recommendations and grassroots guidelines was crafted to support more peaceful and productive land use co-existence in the Nanumba South District. The process was guided by Participatory Action Research (PAR), which ensured that community members actively shaped problem definition and response strategies. Additionally, Conflict-Sensitive Resource Management (CSRM) principles were applied to ensure the proposed actions were attuned to local power dynamics and historic land use tensions (Benjaminsen & Ba, 2009; Chevalier, 2019).

3.7.2. Stakeholder-Driven Approach

The resulting model incorporated specific protocols for land tenure arrangements, conflict resolution, and designated grazing zones. Stakeholder input was integrated at each stage of the model's development to ensure its relevance and accuracy. During FGDs and interviews, participants provided insights into preferred strategies for land use co-existence, which were translated into model components that reflected community priorities and customary practices. This stakeholder-driven approach ensured the model's adaptability to other regions facing similar land use challenges, aligning with established practices in conflict resolution and participatory planning (Chevalier, 2019).

3.8. Ethical Consideration

This research was conducted in full compliance with the ethical guidelines of the University of Twente's Faculty of Geo-Information Science and Earth Observation. Ethical approval was granted under application number 241136. The study involved human participants and addressed sensitive issues related to land use conflict, requiring careful attention to ethical risks and community sensitivities. Through written and verbal communication, participants were fully informed of the study's purpose, procedures, and rights. Information was provided in local languages (Konkomba and Twi) with the support of a translator to ensure clarity and inclusiveness. Informed consent was obtained in writing or verbally, depending on the participant's literacy level. Participation was voluntary, and participants were free to withdraw at any point or refuse to answer specific questions without penalty.

Given the potentially sensitive nature of the research topic, several mitigation measures were implemented. Sessions were scheduled to minimize disruption to daily activities, and culturally appropriate methods were used to avoid offense or distrust. Confidentiality was maintained by anonymizing all data, using coded identifiers, and securing digital records on encrypted, password-protected devices. No personal identifiers were included in published outputs.

Special care was taken during focus group discussions, where participants were informed of the possibility that others might disclose what was shared, which is beyond the researcher's control. Group norms regarding respect and confidentiality were discussed at the beginning of each session to minimize this risk. Refreshments were provided during sessions as a gesture of appreciation, but no monetary compensation was offered, in line with ethical guidance to avoid undue influence. These ethical safeguards ensured the study was conducted with transparency, cultural sensitivity, and respect for participant anonymity, privacy, and well-being. Additionally, Grammarly, an AI-based writing assistant, was used to support language clarity and grammar refinement during the thesis writing process.

3.9. Chapter Summary

This chapter employed a mixed-methods approach to investigate land use conflicts in the Nanumba South District, Ghana. Data was collected through interviews, focus group discussions, and participatory mapping in three key communities. Qualitative insights from local stakeholders were combined with spatial data to develop a practical model for land use co-existence. Spatial analysis using GIS tools helped identify conflict hotspots between farming, grazing, and settlement areas. The model supports conflict resolution and informed policy recommendations. Ethical standards were adhered to, particularly in obtaining informed consent, maintaining confidentiality, and demonstrating cultural sensitivity.

4. RESULTS AND FINDINGS

This chapter presents the key empirical findings from fieldwork conducted in three communities, Lungni, Kanjo, and Gbungbaliga, in the Nanumba South District of Ghana.

4.1. Land Tenure Arrangements in Nanumba South District

There are no formal land titles or registration systems in these communities. Instead, land rights are validated through symbolic practices such as pouring libations or invoking ancestral blessings. While these rituals hold significance within customary systems, they provide no legal protection, especially for transient or non-indigenous groups such as pastoralists. This absence of formal recognition leaves pastoralists vulnerable and complicates conflict resolution when such conflicts arise, as the local farmers are familiar with their land boundaries in their traditional way. Conflicts become difficult because farmers mention traditional authority and ancestral claims, while pastoralists have no equivalent legal or cultural footing to defend their position (Field Data Collection).

Among the groups frequently mentioned are the Fulani, a nomadic pastoralist ethnic group whose members primarily herd cattle and often move seasonally in search of grazing lands. Their presence in the district reflects broader mobility and land access patterns in the northern region of Ghana. Also central to local governance are assembly members, elected community representatives within Ghana's district assembly system, who often mediate land and development conflicts.

The participants addressed these issues in their responses to land tenure arrangements in all the communities. One farmer in Lungni stated, "*The land is mine; I did not buy it. I inherited it from my family*". A recurring sentiment across the communities is that land is not viewed as a market commodity but as ancestral heritage. As one community leader in Lungni stated, "*Land is for the family; we do not sell it. It is passed on like a name*". This cultural principle informs access and decision-making around land, reinforcing its embeddedness in kinship and tradition. In Kanjo, land tenure continues to reflect customary norms, with land passed through patrilineal inheritance and managed by family or clan heads. A clan head explained, "*If someone wants to farm, he chooses the land, and we allow him. Nobody pays for land here, and we do not give documents*".

In contrast, pastoralists, particularly Fulani herders, face more precarious access. They do not own land and can only use it for grazing through informal verbal agreements with landowners or traditional leaders. These arrangements are temporary and can be revoked at any time. A clan head in Gbungbaliga explained, *"For the Fulani people, you only give them land to use for the meantime. You can take it back anytime"*. Likewise, in Kanjo, another clan head mentioned, "*For Fulani people, we do not give them land to pay or own; we allow them to use it for grazing and take it back anytime, and they use the land temporarily*". One herder in Lungni noted, "*I stay here because someone gave me the land temporarily. If they change their mind, I must leave*". They depend on trust-based arrangements with no legal or traditional ownership rights. Pastoralists themselves acknowledged they own no land but often face overlapping claims regarding the areas they are allowed to use. These are not ownership claims, but informal grazing arrangements or permissions that are frequently verbal, undocumented, and subject to conflict, especially when different land users believe they have priority over the same space (Field Data Collection).

In both Lungni and Gbungbaliga, pastoralists consistently highlighted the absence of secure tenure. Many of them live under borrowed legitimacy and are allowed to stay through verbal permissions granted by

influential locals. One Fulani pastoralist explained, "*I stay here because my master brought me. If he decides to move, I must go too*". This statement explains their lack of direct landholdings as they work for indigenous people, perpetuating insecurity and limiting their stake in community land governance. Interestingly, some farmers in Kanjo said they rent land or share it, sometimes for money, suggesting an evolving shift in practice, though still without formal or legal backing (Field Data Collection).

In the Nanumba South district, land is held under customary tenure, overseen by family heads, clan leaders, and chiefs who manage allocation. Across all the three communities where data were collected, respondents consistently reported that land is inherited rather than bought or leased, especially among farming households. The results here were based on the context of responses and are arranged in that order, not on the community context (Field Data Collection).

Figure 6 summarizes land tenure-related issues raised by respondents across the three communities. This chart visualizes how frequently key land tenure topics emerged in participant responses. The most cited issues were customary land allocation, the role of traditional authorities, and pastoralist access rules. These issues reflect the central challenges participants face in navigating land use. Less frequently mentioned but still relevant were concerns such as gender and equity access gaps. The projection of specific themes helps guide the focus of analysis in the following results and discussion sections.

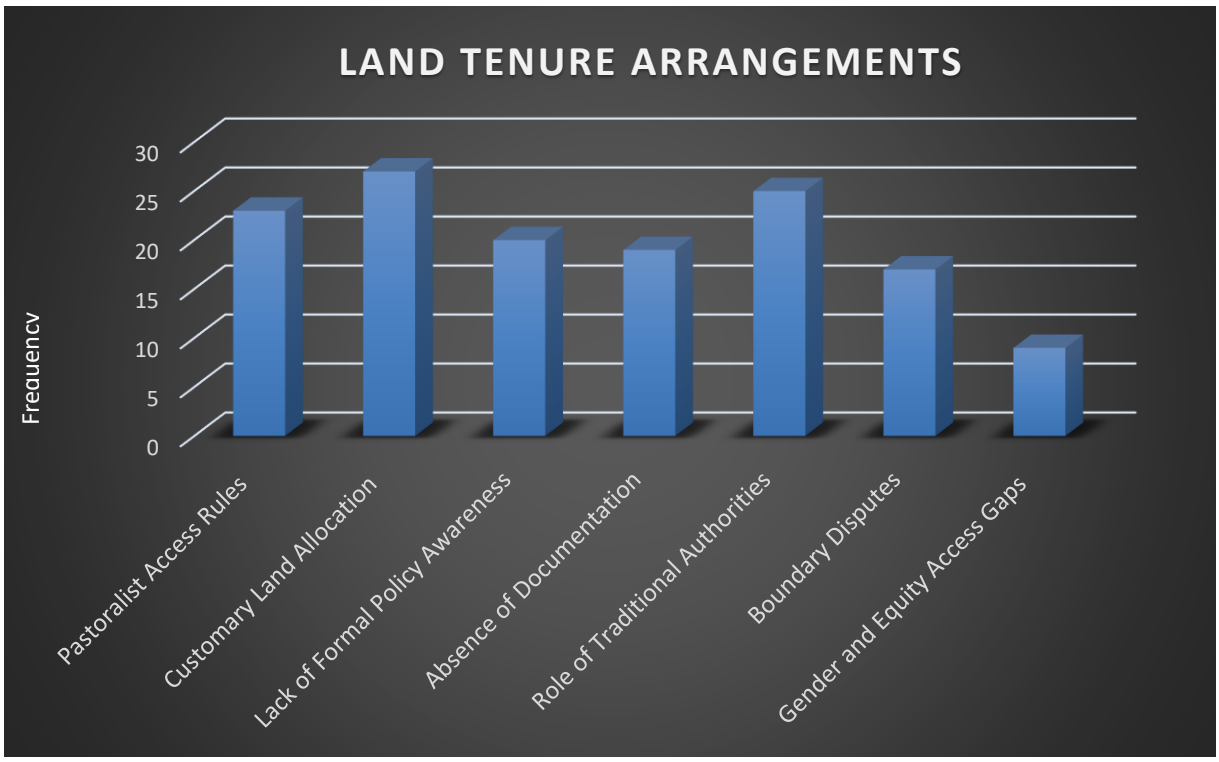

Figure 6: Frequency of key themes raised during discussions on land tenure arrangements.

4.1.1. Land allocation

Land allocation in the communities is embedded in customary systems, where family heads or clan heads and chiefs serve as custodians and decision-makers. Among Indigenous farming households, land is primarily allocated based on inheritance. It is common for land to be redistributed within extended families

when younger members establish their households or farms. These transfers do not involve payment, written documentation, or statutory land ownership procedures.

Land redistribution is highly dynamic within extended families, especially during farming seasons. In Lungni, a farmer stated, "*If the land I am using becomes too small, I speak to my elder brother or uncle. They will move me to another piece within the family land*". Another farmer in Lungni stated, "*I got the land from my father. He also got it from his father. That is how we do it here*", reflecting the generational continuity in access and control. Land allocation in Kanjo follows verbal agreements guided by traditional authority. The process often begins with the individual identifying the land, followed by approval from a clan head or community elder. "*If you want to farm, you just show us the site. If nobody is using it, we allow you,*" said a Kanjo elder. On the other hand, one government official from the Lands Commission acknowledged that there is a need for land allocation done with mapped boundaries: "*If chiefs give land, there should be a clear demonstration of limits for both pastoralists and farmers. Otherwise, one activity interferes with the other*".

Pastoralists, by contrast, face a rotational access system marked by seasonal relocations. A focus group in Kanjo revealed that, "*When the dry season comes, they [Fulani] shift to another end of the community. They only stay where the grass and water last*". Additionally, herders noted that when grazing access is granted, it often comes with time restrictions. A community leader in Gbungbaliga stated, "*They are told to graze only from morning to evening, no night movement. But many still graze in the night, which causes problems*". These patterns reflect a land use practice shaped more by environmental conditions than formal or customary allocation. However, landowners may grant temporary access to grazing land, but this informal, undocumented arrangement is subject to withdrawal when the landowners need or want their lands back for different purposes. A clan head in Gbungbaliga remarked, "*We give the Fulani land to use, but it is not forever. If there is a problem, we take it back*". Another clan head in Kanjo emphasized, "*They do not pay or own the land. We just allow them to use it for grazing, and we can take it back at any time*".

The allocation process is often accompanied by symbolic rituals. Respondents across the three communities noted that the act of pouring libations or invoking ancestors marks the traditional endorsement of land transfer. While this holds weight within local culture, it offers no formal and legal proof of ownership or boundary demarcation. As such, land remains within the family trust, and claims are passed down orally. Pastoralists, especially Fulani herders, are not considered part of the customary landholding system and, therefore, face more conditional arrangements with land allocation (Field Data Collection).

4.1.2. Awareness of Land Policies

Data collected across the communities show that community members' awareness of statutory land policies is generally low. Respondents reported a limited understanding of national frameworks governing land, with land management continuing to be influenced by customary norms and traditional authority.

Awareness of national land policies remains low across Kanjo and Lungni. A community leader in Kanjo admitted, "*We do not know any land registration policies. Everything here is done the traditional way*". In Lungni, some elders and community leaders stated that they had never interacted with land administration authorities or received guidance from the Lands Commission. One elder remarked, "*We have not seen any land officers here. We only know what our elders taught us about land*". Similar responses were recorded in Gbungbaliga, where participants indicated that no external actors had ever come to educate or inform them about land rights or statutory land ownership procedures. Customary practices were viewed as the only legitimate means of managing land, and none of the respondents mentioned familiarity with national land-related legislation, including land titling or registration processes.

Furthermore, in Kanjo, the narrative was the same as the respondents knew nothing about land policy actors or institutions, let alone formal engagement with them. Across all three communities, there was no evidence of institutional coordination between customary authorities and formal land administration bodies (Field Data Collection). A common theme was the complete absence of state presence in land matters. As one community leader in Kanjo said, "*We have never seen anyone from the Lands Commission here. Everything we know is from our fathers*". Several participants also expressed a desire to be educated on formal land policies. One community leader from Lungni noted during a focus group discussion: "*If the government wants us to register land or follow new rules, they should come and teach us, not just write in Accra*".

Even pastoralists confirmed they were unaware of any formal rules governing grazing rights. "*Nobody tells us how to use the land. We graze where we can*," said one of the pastoralists. The interviews and focus group discussions revealed minimal awareness of formal land policies among pastoralists. Many pastoralists openly stated they had never received information about official rules or government guidelines governing grazing rights. A pastoralist in Lungni stated, *"There is no policy we know of. When they give you land, you use it. No one says, 'Do it like this or that".* Several pastoralists explained that their understanding of land use was based solely on informal arrangements with local landowners or traditional authorities. *"We have never been taught about government laws. We only know the rules the landowners or chiefs tell us,"* said a pastoralist in Kanjo. Others expressed frustration with restrictions they did not fully understand, noting, *"Sometimes the land is not even being farmed, but the owner still says we should not let our animals graze there."*

Meanwhile, government efforts to formalize land use exist mainly on paper. One Lands officer in Tamale noted that "*land use plans allocate space for farmers, traditional authorities, and vulnerable groups, but implementation is poor due to traditional barriers and poor awareness*". Furthermore, interviews with government officials at the Land Commission indicate that policies and spatial planning mechanisms do exist, at least at the administrative level. According to a surveyor with the Land Commission, land use plans are developed with input from multiple agencies and provide equitable land access, including allocations for women, widows, and less privileged groups. He explained that "*the land use plan gives portions of land to traditional authorities, farmers, and vulnerable groups like women and widows*". While these plans are documented, the official acknowledged gaps in communication and collaboration with communities, noting that boundary demarcation is often poorly defined and that many local actors are unaware of these plans. This disconnect between policy design and local awareness contributes to the ongoing prevalence of customary systems and the marginalization of statutory frameworks in everyday land administration.

However, as the government and stakeholders work effectively for land administration reform in Ghana, respondents in all three communities reported that land administration knowledge remains rooted in customary practices. Nearly all the respondents stated they had never interacted with government land officials and had received no information about cadastral systems, titling, or land registration (Field Data Collection).

4.1.3. Institutional Collaboration

The study's noticeable findings highlight a complex relationship between formal land administration institutions and traditional authorities in the Nanumba South District. While both entities play roles in land administration, the level of collaboration between them is uneven and often hindered by logistical, structural, and political challenges.

In interviews with officials from the Land Commission, it was noted that customary authorities control approximately 90% of the land in the Northern Region, including Nanumba South. As a result, land administration in the district heavily depends on the cooperation of chiefs, family heads, and clan heads.

According to a government surveyor, "*Our activities are always in collaboration with traditional authorities through boundary demarcation, base map preparation, cadastral planning, and land registration*". This suggests that formal institutions recognize the importance of engaging traditional custodians in implementing land policies.

The collaboration between formal institutions and customary authorities in the Nanumba South District is inconsistent. In theory, officials from the Lands Commission are to work alongside traditional leaders on planning, mapping, and land registration. However, there are weak enforcement efforts due to local conflicts, especially with chieftaincy. "*We always work with chiefs, but chieftaincy conflicts and undefined boundaries delay everything,*" said another Lands Commission official. The same official acknowledged that boundary disputes among traditional authorities often obstruct the work of the Land Commission, stating that "*Most of the time, these gaps arise from chieftaincy disputes and poor boundary demarcation on the ground*".

However, these chieftaincy conflicts delay mapping exercises and limit the effectiveness of formal institutions in carrying out their mandates. Furthermore, the Land Commission officials explained that spatial plans are prepared to designate specific areas for farming, residential use, grazing, and community infrastructure. However, no consistent mechanism exists to translate these plans into community-level action. As noted in the interviews, most residents in the three communities are unaware of these plans, and there is minimal follow-through in ensuring that allocated zones are respected or monitored (Field Data Collection).

4.1.4. Discussion of Results for Sub-Objective One

Customary land allocation is still the main way land is accessed and controlled in the Nanumba South District. Land is passed down through families, mostly from fathers to sons, and the elders and clan heads make decisions about who gets what. These arrangements function without formal documentation or statutory oversight, echoing what Lengoiboni (2011) describes as deeply embedded customary systems which are deemed effective in local terms but legally ambiguous. However, land redistribution is highly relational and responsive. Younger members of extended families negotiate land use with elders as household needs evolve, creating a dynamic, adaptive structure. Furthermore, this flexibility sacrifices legal clarity, emphasizing that without written records or defined boundaries, such claims are difficult to defend in conflicts or when land becomes more valuable, exposing a structural vulnerability in the face of modernization or external encroachment (Field Data Collection).

For pastoralists like the Fulani, the situation is even more complicated. They are not considered part of the landholding community, so they do not inherit land. Instead, they rely on temporary, informal agreements with landowners that can be revoked at any time. Herders often face limits on when and where they can graze, and some are banned from moving at night. This reflects what Robinson and Flintan (2022) describe as a familiar pattern, where mobile land users are often left out of customary and formal systems, leaving them with no secure claim to land they have used for generations. Similar dynamics have been documented in other Ghanaian regions, where neo-customary systems have adapted to accommodate newcomers without offering tenure protection (Ablo, 2024). While these informal arrangements may function in the short term, they offer no stability and often leave pastoralists vulnerable to eviction and exclusion.

Awareness of land policies in these communities is almost non-existent. Most respondents had never engaged with the Lands Commission, seen a cadastral map, or been informed of land registration procedures. Land continues to be governed by tradition simply because formal institutions have not engaged these communities. This supports findings by Adomako (2019), who shows that many rural areas in Ghana are cut off from statutory land systems due to weak institutional outreach. However, one important aspect observed across the communities was that people want to learn. Several participants expressed an interest in learning about registration, titling, and land rights, noting that the government must actively bring that

knowledge to them. Informal land renting in places like Kanjo indicates that land practices are evolving without the support or safeguards that formal recognition would provide. There is a window of opportunity for policy to catch up with practice (Field Data Collection).

Pastoralist communities appear even more disconnected. Their grazing strategies are based on seasonal movement and environmental adaptation, not on any known legal framework. This disconnect leaves them without statutory protection, making them vulnerable to restrictions, land grabs, or forced relocations. Robinson and Flintan (2022) highlight how such legal invisibility is a common feature of pastoralist experiences across Africa, where communal and mobile land use remains unaccounted for, mainly in formal planning.

Institutional collaboration between formal land management agencies and traditional authorities remains weak and uneven. Officials from the Lands Commission confirmed that plans exist at the district level, but limited resources, unclear mandates, and local resistance hamper implementation. In practice, land management remains almost entirely customary. This leads to overlapping claims, uncoordinated development, and poor integration of pastoralist needs. Scholars have described this as "institutional duality," where formal and informal systems operate in parallel without coordination (Arko-Adjei et al., 2010). However, residents had never participated in spatial planning in all three communities, and there was no local knowledge of land use zones or demarcation exercises. Chieftaincy conflicts and contested boundaries further hinder coordination efforts, issues that have historically obstructed regional land administration, as Lengoiboni (2011) also observed.

Furthermore, where formal spatial plans exist, they are not translated into practice at the community level. The lack of enforcement mechanisms and follow-through means that statutory intentions remain abstract, with no real effect on land use patterns or conflict resolution. This gap can inflame tensions in contested zones, as land users operate without a clear sense of where rights begin or end (Field Data Collection). To fix this, collaboration must move beyond talking and consultation to implementation. Participatory models such as community-led mapping, boundary identification, and establishing local land committees offer practical tools to close the gap between customary and statutory systems. Brown and Raymond (2013) demonstrated that integrating community values into land governance strengthens legitimacy and reduces conflict.

In conclusion, the Land tenure arrangements in Nanumba South District are shaped by customary systems, where traditional authority chiefs, clan heads, and family heads exercise control over land allocation. Farming households primarily access land through inheritance rather than purchase or lease. This reinforces the idea of land as ancestral property, embedded in lineage and kinship rather than market transactions. As Arko-Adjei et al. (2010) highlighted, modes of access to land do not just describe customary tenure systems in Ghana; instead, there are cultural institutions deeply tied to identity, belonging, and social structure.

4.2. Land Use Co-existence and Conflict

In Nanumba South District, the co-existence of land users, particularly between Fulani pastoralists and indigenous farmers, is defined by informal, often fragile arrangements. As land pressure intensifies during the dry season, competition over farming and grazing space leads to frequent conflicts. In all three communities, Lungni, Kanjo, and Gbungbaliga farmers described recurring destruction of crops by cattle. A farmer in Lungni said, "*They [Fulani] do not control the cows well. They come at night and spoil the farms. Even when you catch them, they deny it*". In Gbungbaliga, another farmer echoed this frustration: "*The cattle pass through my farm, spoil the yams, and then they say it is not their cattle*".

Pastoralists shared their concerns, particularly about access to land for grazing. A herder in Gbungbaliga noted, "*Sometimes the land is not even being farmed, but they still say we should not graze there*". Others emphasized that they are often blamed for destruction caused by animals they do not own. "*If an animal mistakenly enters a farm, we are made to pay even if it is not ours,*" said a pastoralist in Lungni. Water sources are another flashpoint. Dams and rivers within the communities are used both for irrigation and drinking by animals, leading to regular tension, especially in the dry season. In Gbungbaliga, one community leader stated, "*We all use the same dam. When cows step in, it becomes a fight*".

Some community leaders spoke about the co-existence and integration between the pastoralists, the farmers, and the community. A clan head in Gbungbaliga stated, "*Some of the Fulani are not strangers. They were born here, their fathers were here, and they take care of our animals*". Given this statement, the herders are embedded within the community, and interactions with farmers tend to be more agreed upon by social norms than rigid rules. However, these peaceful arrangements are not universal. Where herders are perceived as newcomers or "outsiders," interactions quickly shift from cooperative to adversarial. A community leader in Kanjo explained, "*The ones who have lived here for long, we know them, but the new ones come and do not respect our ways. That is where the problems start*". These newcomers often lack the social capital needed to negotiate space, and their behaviour leads to mistrust.

A significant factor driving conflict is the absence of designated grazing areas or cattle routes. In Kanjo, a clan head admitted, "*We do not have official areas for the animals. They just move where they find grass*". Farmers across the sites expressed concern about the increasing strain on land. "*There is no space anymore. We are many now. The animals are many too*," one Kanjo farmer said. Beyond physical space, relationships have also deteriorated. During a focus group in Lungni, some discussants explained, *"We used to go to funerals together, but now, land issues have divided us*". A farmer in Gbungbaliga added, "*Even our children do not play together like before. When animals destroy farms, it becomes a family fight*".

Figure 7 summarizes the co-existence and conflict issues related to land use as raised by respondents from the three communities. This chart highlights the dominant themes from interviews and focus group discussions about conflict and co-existence in land use. Traditional conflict resolution mechanisms were the most frequently mentioned, representing approximately 15% of all responses, nearly three times more frequent than police conflict resolution, which accounted for just 5%. Relationship tensions and crop destruction by cattle were also highly cited, reflecting key stress points in pastoralist and non-pastoralist interactions. The data emphasize the community's reliance on traditional systems and the limited role of formal law enforcement in resolving conflicts.

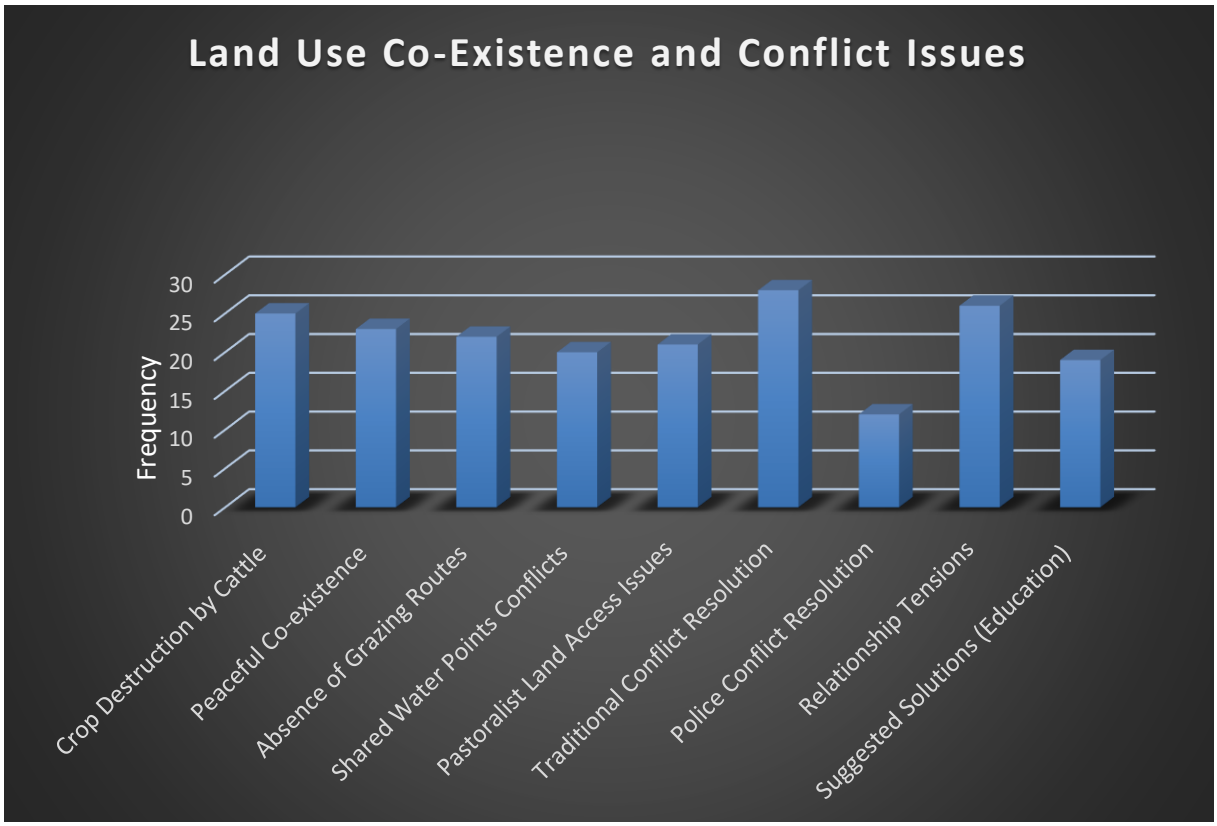

Figure 7: Frequency of Land Use Co-existence and Conflict issues among participants

4.2.1. Patterns of Interaction

Empirical findings for this study suggest that the co-existence of land use between farmers and pastoralists in Nanumba South District is highly situational, often shaped by personal relationships, social embeddedness, and seasonal constraints. In both Lungni and Kanjo, some degree of peaceful cohabitation exists under specific social arrangements, particularly Fulani herders who rear livestock for indigenous families. A woman farmer in Lungni remarked, "*I cannot ask them to pay even when they destroy my farm because the cows are for my relatives*".

Seasonal patterns heavily influence the interaction dynamics. Respondents across all three communities consistently identified the dry season as the most tense period, due to the scarcity of both water and pasture. During this time, pastoralists move closer to farmlands and shared water sources, increasing the risk of crop encroachment. A farmer in Gbungbaliga said, "*We have peace during the rainy season because everyone is busy. But in the dry season, the animals start moving around, and that is when the fights begin*". Tensions also rise during planting and harvest seasons when crops are vulnerable. Most farmers reported that Fulani herders sometimes graze cattle too close to newly planted fields or enter harvested areas where residual crops remain. "*They say the farming is finished, but the yams are still there. If a cow enters, it can still cause damage,*" explained a Kanjo farmer.

Even within families, these seasonal pressures introduce a pattern of conflicts. One farmer in Lungni stated, "*My brother works with the Fulani, and when his cattle spoil my land, I cannot complain too much. But it still causes tension at home*". Focus group discussions also revealed that farmers often distinguish between "well-behaved" and "careless" herders. A group of farmers in Gbungbaliga noted, "*Some Fulani know how to manage animals, they guide them well. But others let them roam anywhere. Those are the ones we fear*". This suggests that interaction patterns are influenced not just by identity but by perceived responsibility and respect for local norms.

On the pastoralist side, many felt they were unfairly stereotyped regarding interactions on crop destruction by the cattle. A herder in Kanjo shared, "*When one cow spoils something, they blame all of us. Even if it is not ours*". Another herder in Lungni mentioned that their interactions with farmers worsen when farmers exaggerate crop damage to demand excessive compensation: "*Sometimes the farm is small, but they say it was big. They just want to punish us*". However, there were calls for better communication. "*If we can sit together and plan where to pass with our animals, the problems will reduce,*" said a pastoralist in Gbungbaliga. Some community leaders and assembly members agreed, emphasizing the need for structured community dialogue and joint planning, especially before farming seasons begin.

Furthermore, the patterns of interaction between pastoralists and farmers are profoundly shaped by personal ties, historical presence, seasonal shifts, and behaviour. While peaceful co-existence is possible and often evident, it is highly fragile and easily disrupted in contexts where relationships are weak, space is limited, or expectations are unspoken (Field Data Collection).

4.2.2. Triggers of conflicts

Several recurring and interconnected factors trigger land use conflicts between pastoralists and non-pastoralists. The most widely reported of these include crop destruction by cattle, dry-season movement, competition over water resources, absence of grazing routes, land scarcity, and difficulties with herd accountability. These triggers appeared consistently across all the interviews and focus group discussions (FGDs), with 80% of the participants, including farmers, herders, community leaders, and other local stakeholders, highlighting more on crop destruction (Field Data Collection).

Farmers repeatedly cited this crop destruction as the most common and immediate cause of conflicts. During interviews and group discussions, many farmers shared accounts of cattle entering their farms, particularly yam and cassava plots, resulting in significant loss of produce. A farmer in Lungni remarked, "*The Fulani do not take good care of the animals and always leave them to find food for themselves*". In Gbungbaliga, multiple farmers reported that damage typically occurs at night when animals are left to graze unsupervised. Some respondents also mentioned the deliberate release of cattle into harvested areas where residual crops remain, further escalating tensions. In several interviews, farmers and herders pointed to herd management challenges, particularly where livestock is owned by urban-based elites but managed by local Fulani. According to a police officer, "*When the animals destroy crops, it is hard to know who to hold responsible. The owners are not here, and the boys managing the herds are sometimes too young*". This lack of clear accountability complicates compensation arrangements and weakens the effectiveness of traditional conflict resolution mechanisms.

Seasonality, especially the dry season from January to March, intensifies land use pressure. Pasture and water availability decrease during this period, forcing pastoralists to move their herds closer to settlements and cultivated land. As one herder in Lungni noted, "*The land is not large for the animals. Sometimes they enter farms because there is no space*". This seasonal convergence of land use heightens the risk of conflict as both groups compete over shrinking resources. Community leaders in Kanjo and Gbungbaliga also acknowledged that these months are the most volatile, often requiring their direct intervention to mediate conflicts (Field Data Collection).

Water resources were identified as triggers. Shared dams, rivers, and ponds used by farmers and herders become hotspots for conflict, particularly when livestock contaminate water sources used for domestic or irrigation purposes. A clan head in Gbungbaliga explained, "*That is where the trouble starts; the cows and people go to the same dam.*" In several communities, participants called for separating watering points for livestock and

human use to reduce friction. The absence of designated grazing routes and corridors further strains land use relations.

Cattle routes were another trigger for these conflicts. Without mapped or agreed-upon routes, herders frequently move their cattle through farmlands, often unintentionally causing damage. A Fulani pastoralist in Kanjo expressed this challenge: "*There are no cattle routes. To move cattle, we have to pass through farms. That is where problems start*". Without spatial planning or enforceable bylaws, both groups operate on overlapping and undefined territories, heightening the potential for conflict. Some respondents also highlighted the failure to fence farms, especially those near settlements, as a contributing factor. Farmers acknowledged that it becomes difficult to prevent or prove trespassing when boundaries are unclear. In Gbungbaliga, a pastoralist shared, "*Sometimes the farm is near the road and not fenced, and the cattle just go there. Then we get blamed*".

Land scarcity was another recurring issue, particularly in Lungni and Gbungbaliga. Farmers reported that previously unused buffer zones or forested areas have been converted into farmland due to population growth and agricultural expansion. A farmer in Lungni stated, "*Before, there was space between farms. Now everything is close together. If cattle walk, they step on someone's crops*". Herders, on the other hand, described increasing difficulty in finding grazing areas within or near the community, often attributing the problem to the loss of traditional commons and the lack of alternative grazing zones (Field Data Collection).

Furthermore, tensions are high when interpersonal relationships are weak or absent. Conflict is often less about the actual damage and more about the social distance between the parties involved. Farmers tended to express more tolerance when the herders were long-time residents or managed cattle belonging to local families. Conversely, tensions escalated when the pastoralists were seen as recent arrivals or outsiders without ties to the community (Field Data Collection).

4.2.3. Enforcement of Local Rules

While customary rules exist to regulate land use and prevent livestock encroachment on farms, their enforcement is uneven and heavily dependent on the authority and discretion of traditional leaders. In Lungni and Kanjo, clan heads and community elders often instruct herders to keep cattle away from cultivated areas. A clan head in Kanjo explained, "*We tell them not to graze near the farms, but if they disobey, we just warn them or tell them to leave. We do not always fine them*". This discretionary enforcement creates inconsistency, particularly when the offenders are socially connected or economically powerful.

Herders themselves acknowledged the expectations placed on them. One caretaker in Lungni noted, "*If you rear animals and they spoil someone's farm, you, the caretaker, should report to the owner, and the owner must pay compensation*". However, as many respondents observed, compensation is not governed by any standardized procedure. Instead, it is negotiated on a case-by-case basis, often influenced by the relationship between the parties. In Gbungbaliga, a farmer noted, "*If the owner is someone big or connected, they do not pay. But if it is a poor man's cattle, they will force him to pay quickly*".

Issues of livestock ownership and control further complicate the enforcement of local rules in these communities. Many animals are owned by absentee landlords, often local elites, who entrust their cattle to Fulani herders. In several interviews, respondents noted that livestock are sometimes left in the care of young boys who cannot manage them effectively. A farmer in Gbungbaliga remarked, "*You find children driving big herds, and when something happens, they cannot explain anything. They just run away*".

The police also face structural limitations. In Lungni, the officer reported that logistical constraints, especially the lack of vehicles and limited fuel, prevent regular patrols or rapid response to incidents in

remote settlements. "*We want to help more, but we cannot reach everywhere*," he said. Coordination between formal and traditional authorities remains essential but inconsistent. While police often rely on local chiefs or assembly members to identify offenders or enforce sanctions, this is complicated by conflicts of interest, particularly where traditional authorities are also livestock owners. "*Some chiefs have cows too*," the police officer explained. "*So, when their animals spoil someone's crops, they are reluctant to act strongly*".

Sensitization campaigns are sometimes organized to address these challenges, targeting herders and farmers with information on acceptable grazing practices and conflict prevention. However, these initiatives are infrequent and often lack follow-up. As the police officer emphasized, "*The real problem is structural. Without designated grazing lands and clear rules, these conflicts will not stop*." Finally, while enforcement structures exist in principle, they are weakened by informality, limited resources, and overlapping interests. The lack of designated spaces for pastoralists, combined with divided authority and unclear accountability, continues to undermine efforts to maintain peaceful coexistence in the district.

4.2.4. Discussion of Results for Sub-Objective Two

The study revealed that land use co-existence between farmers and pastoralists is possible under certain conditions, especially when there are personal relationships or shared economic interests. In some cases, Fulani herders rear livestock for local families, providing a practical incentive for cooperation. This reflects what other researchers describe as "adaptive co-existence," a strategy where social networks help manage land use despite the absence of formal regulation (Ibrahim et al., 2025; Narh, 2024).

However, these arrangements are fragile and under increasing strain. Seasonal scarcity of pasture and water, particularly during the dry season, pushes herders into farmed areas. Farmers, in turn, become more defensive of their land, especially when livelihoods are threatened. Ongoing changes in land use patterns, such as agricultural expansion into previously open areas, intensify this pressure (Ayantunde et al., 2011; Sarfo et al., 2024; Turner et al., 2012). These changes destabilize informal coexistence, making conflict more likely and more complicated to resolve.

Without mapped boundaries or designated zones, both groups operate in overlapping spaces. While interpersonal trust may be a temporary peacemaker, such arrangements are not sustainable in the face of growing land pressure and environmental change. As Otu and Impraim (2021) argue, informal co-existence becomes increasingly ineffective when land governance fails to keep up with spatial and demographic realities. The findings confirm what other scholars have argued: land scarcity, in itself, does not automatically lead to conflict, but unmanaged scarcity does (Sarfo et al., 2024; Alhola & Gwaindepi, 2024). When institutions fail to mediate access and use, individual survival strategies come into direct conflict, and local resolution mechanisms become overburdened.

Social ties, seasonal changes, and the local logic of land use shape patterns of interaction between pastoralists and farmers in communities. Peaceful co-existence often depends on personal relationships, especially when Fulani herders manage livestock for local families. As one farmer said, "*I cannot ask them to pay even when they destroy my farm because the cows are for my relatives.*" This supports Nielsen and Reenberg (2010), who note that local embeddedness can mitigate conflict.

Perceptions of responsibility further shape conflict. Farmers distinguish between "careful" and "careless" herders, while herders feel unfairly blamed for others' actions. A Fulani respondent said, "*When one cow spoils something, they blame all of us.*" Still, both sides called for joint planning and communication to reduce conflicts, a view supported by Scoones (2020), who emphasizes inclusive dialogue for conflict reduction.

Key conflict triggers include crop destruction, lack of grazing routes, water access, and land scarcity. Crop damage, especially during night grazing, was the most cited issue. Unclear livestock ownership complicates accountability, particularly when young herders manage animals on behalf of urban elites. A police officer noted, "*It is hard to know who to hold responsible*." This echoes Scoones' (2020) findings on the governance challenges posed by absentee ownership. The absence of mapped cattle routes forces herders through farmland, increasing tension. A Fulani herder said, "*To move cattle, we have to pass through farms*." Spatial overlap reflects broader legal and tenure mismatches between pastoral mobility and sedentary farming (Lengoiboni, 2011). Meanwhile, expanding farmland has reduced traditional buffer zones, making encounters more likely. This pattern has been widely observed in Ghana and across West Africa, where farmer–herder tensions follow predictable seasonal and spatial rhythms (Alhassan et al, 2024).

Rule enforcement is uneven and often influenced by power dynamics. Traditional leaders may issue warnings but avoid fines, especially when livestock owners are influential. "*If the owner is someone big, they do not pay*," one farmer remarked. This aligns with Benjaminsen and Ba (2019), who argue that elite capture often compromises land governance. Formal enforcement is also limited. Police cite a lack of logistics and inconsistent coordination with traditional leaders, some of whom own cattle. Occasional sensitization campaigns occur but lack follow-up. As one officer concluded, "*The real problem is structural. Without clear rules and grazing areas, the conflicts will not stop.*" This reinforces calls by Catley et al. (2013) and Scoones (2020) for participatory land-use planning and formal recognition of pastoral systems.

In conclusion, land use co-existence in Nanumba South is shaped by informal arrangements that are often fragile. While some Fulani herders are well-integrated through kinship or long-term residence, peaceful relations depend heavily on personal ties and social familiarity. However, land use co-existence is possible but unsustainable without more explicit rules, designated grazing space, and stronger systems for resolving conflict. Formal support and inclusive planning are essential to move from temporary tolerance to lasting land-use harmony, reducing land use conflicts in the communities.

4.3. Conflict Hotspots Mapping and Spatial Dynamics

Respondents from Lungni identified some areas in the centre of the community as areas where conflicts are more likely to occur due to cattle movement through residential and cultivated spaces. One community leader noted, "*The cows pass through here to reach the bush. There are farms on both sides, and that is where they sometimes destroy crops*". In Gbungbaliga, the dam area was consistently described as a hotspot during the dry season. Both livestock and community members rely on it for water, and the absence of access regulations creates seasonal competition for resources. "*That is where we fetch water. However, during the dry season, the animals also come there. Then we argue over who should use it*," said a local farmer.

In Kanjo, several residents cited conflict incidents near the riverbanks and surrounding bush paths where herders cross to reach water. These locations were noted as unregulated spaces where farming and herding activities intersect. A clan leader explained, "*The cattle pass by the lowlands to drink, but that place is now full of gardens. That is where the fights start*". Additionally, areas on the outskirts of Kanjo where farmland expansion meets grazing activity were reported as high-risk zones.

The police officer supported these observations, citing Lungni and Kanjo as frequent sites of land use conflict. He explained, "*Most of our cases involve crop destruction and encroachment in areas where there are no grazing paths. Some of the conflict hotspots repeat year after year*". The conflicts between pastoralists and farmers often arise due to competition over land resources, with livestock damaging crops or farmers reducing available grazing land, destabilizing agricultural and pastoral livelihoods in the region (Field Data Collection).

4.3.1. Cattle Route Demarcation

Participatory mapping exercises with herders confirmed the absence of formally designated grazing corridors. In Lungni and Kanjo, cattle often move through towns and along main roads to reach peripheral bush areas, with their routes frequently intersecting farmland and residential zones. "*We do not have a line. So, we pass where we can. That is when the problem starts*," stated a pastoralist.

Spatial disorganization has led to recurring conflicts, especially around streams used for irrigation, dam access points, and lowland areas previously reserved for grazing but now under cultivation. Both farmers and herders acknowledged that the lack of zoning infrastructure, whether physical barriers or agreed-upon boundaries, has heightened the frequency and intensity of encounters (Field Data Collection).

These findings align with the broader literature on spatial land conflicts, particularly in agro-pastoral regions where mobility routes are not integrated into land-use planning (Turner, 2004; Ayantunde et al., 2011). The absence of coordinated land administration contributes to immediate conflicts and long-term instability in intergroup relations.

Figure 8 shows a scanned map used during the participatory mapping exercise for Kanjo. Lines drawn by the participants illustrate cattle routes that contribute to overlapping claims, particularly in areas where pastoralist movement intersects with farmland and communities' activities. This mapping exercise provided visual evidence and dialogue prompts that enriched the qualitative interviews and focus group discussions.

Figure 8: Scanned satellite images used for participatory mapping. The black lines represent the cattle routes drawn by participants.

The images in Figure 8 above represent spatial data collected during interviews and focus group sessions with farmers, pastoralists, and local leaders in Konjo. Participants identified known cattle movement routes and conflict-prone areas. The scanned image data for the other communities is shown in Appendix 7.5.

4.3.2. Spatial Distribution of Conflict Hotspots

The hotspot maps generated for the three study communities, Lungni, Kanjo, and Gbungbaliga, show visible concentrations of land use conflict in specific areas where farming and pastoral activities overlap. It is essential to recognize that the ESA WorldCover dataset used in this analysis has inherent resolution and temporal limitations. While its 10-meter spatial resolution is suitable for capturing broad land use classes, it may omit smaller, yet significant landscape features critical for localized conflict analysis, such as narrow pathways, individual structures, and mixed-use boundaries. Consequently, interpretation of spatial results considered these limitations, ensuring that conclusions regarding conflict dynamics were validated through complementary participatory mapping and qualitative data.

The hotspot map in Lungni shows that the conflicts that have been reported most are in the areas where there is a high interaction between cattle movement and farmland use. Some respondents were able to single out multiple areas where there were repeated incidents. According to local pastoralists and farmers, the southern part of the community was commonly referred to as an area of conflict because it served as a grazing corridor and was near cultivated fields. They have places where herders transport animals and encroach on agricultural zones, especially during the dry season. The farmers observed that the streams utilized in watering the farm animals pass through farm areas, and thus, there are recurrent cases where the cattle will encroach on the yam or cassava farms. Mentions were also made of tracks between family homes and the bush through which cattle are regularly driven, enhancing the threat of farm invasion (Field Data Collection).

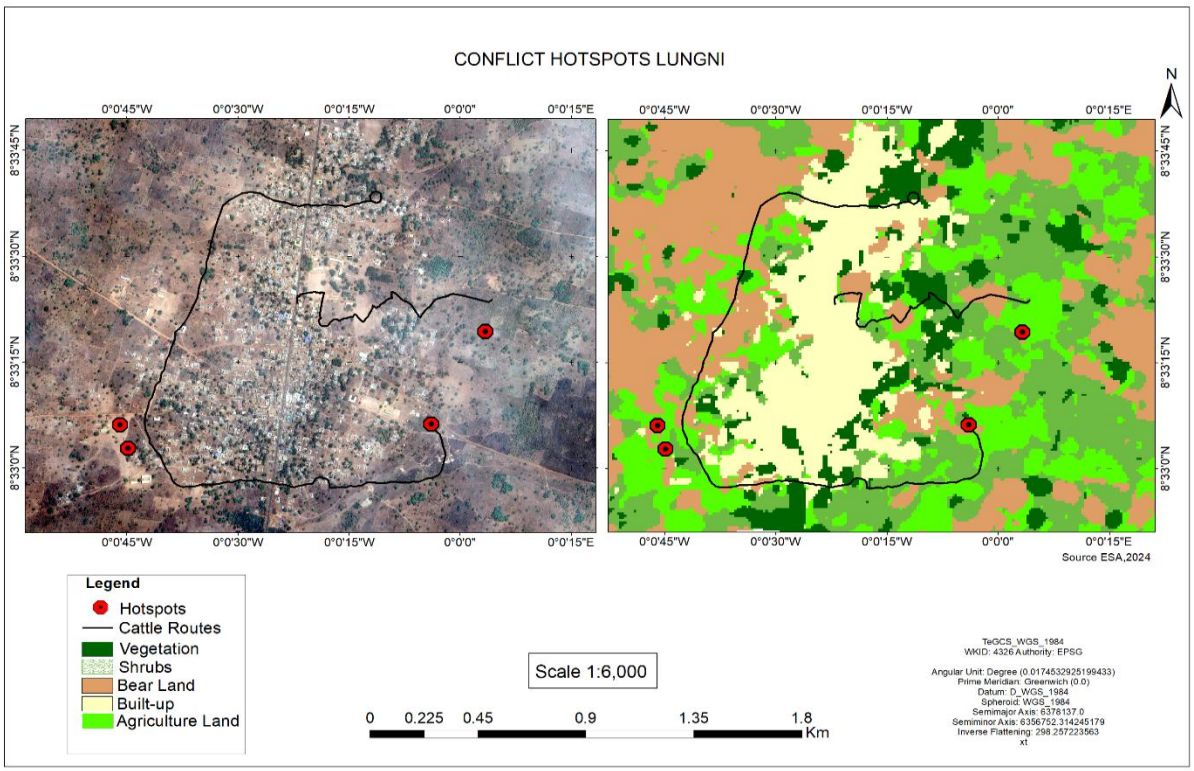

Figure 9: Conflict Hotspot Maps of Lungni

Figure 9 above shows the spatial distribution of conflict hotspots in Lungni, which exhibits a clear pattern of interaction between pastoral movement corridors and zones of intensive land use. As depicted in the LULC map, most hotspots align with the mapped cattle route and are concentrated in areas dominated by agricultural land, shrubland, and settlements. This spatial overlap suggests that land use competition, particularly between herders and farmers, is a significant driver of local conflict.

These results are also reinforced by the unclassified satellite imagery that visually confirms the patterns of land destruction, settlement expansion, and vegetation loss across the cattle corridor. These tensions are further compounded by uneven land distribution and settlement expansion, as seen in the unclassified satellite imagery and the classified map. Hilly terrain decreases the accessible continuous grazing routes, and herders are pushed into cultivated areas, as increasing settlements take over traditional routes and resource zones. Such dynamics lead to increased land-use boundary conflicts, which affirm the application of integrated land management strategies to arbitrate on the competing interests in Lungni.

The hotspot areas in Gbungbaliga are concentrated near common water points and increased agricultural lands, particularly in the east and south-central regions of the community. These locations are where the land pressure is higher in the dry season, as noted in the research by Dary et al (2017) and Zhao & Jurdak (2016). The field data indicated that the conflict-prone areas include those close to the community dam and the forest fringe. Community leaders claimed that farmers and herders share these zones to access water and graze. There were some conflicts as the animals went to drink water at the dam and ended up trampling the crops near the dam (Field Data Collection). One herder pointed to the eastern dam area as the most sensitive zone, stating, "*That is where the animals can still feed, but also where people collect water, so we always get problems there*". Farmers also confirmed that plots along this corridor, particularly those expanded into former grazing lands, see the highest number of encroachment-related complaints.

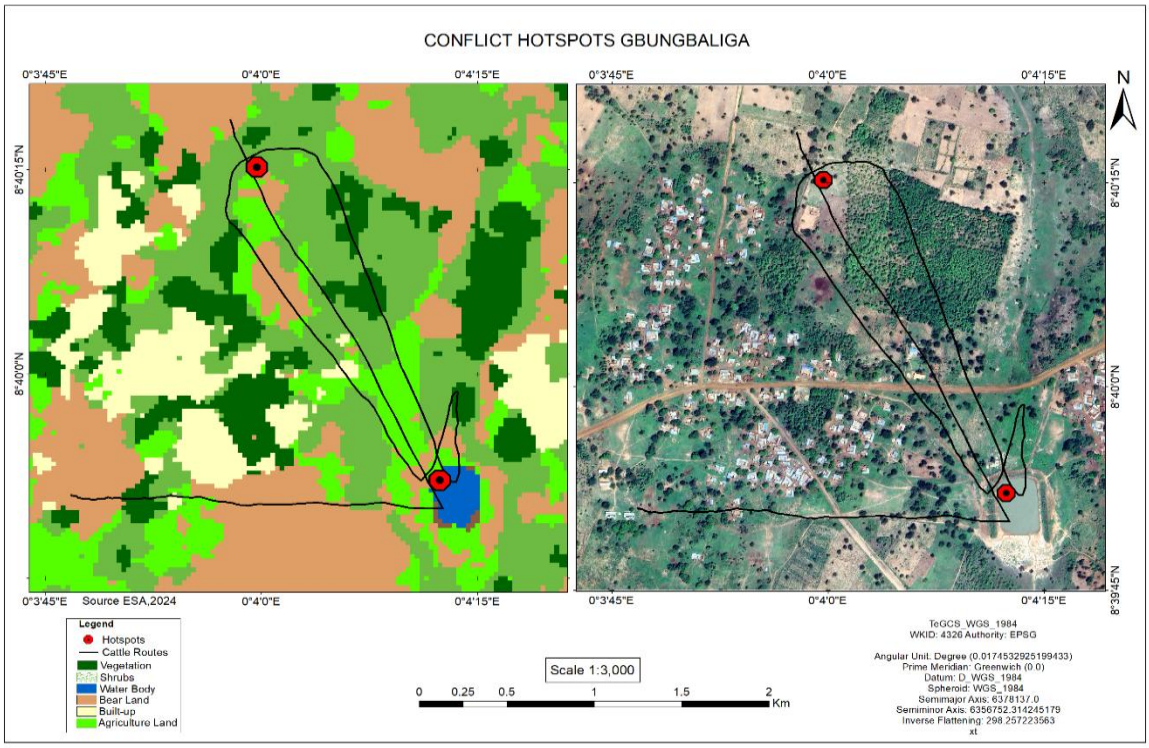

Figure 10: Conflict Hotspot of Gbungbaliga

Figure 10 shows the spatial distribution of conflict hotspots in Gbungbaliga, which reveals a notable interaction between pastoral routes and diverse land use zones. The identified cattle route passes through two key conflict hotspots near intense land use activity areas, including agricultural lands, vegetation zones, and built-up areas. This route intersects cultivated lands and cuts through settlements and patches of dense vegetation, increasing the likelihood of resource-based conflicts, especially between nomadic herders and settled farming communities.

As pointed out by the LULC map, the lower hotspot is located near a water body, agricultural land, and built-up area, which means it is the meeting point of human, livestock, and environmental interests. Although the upper hotspot is located in more vegetated land, it also adjoins farmland and shrubland, indicating seasonal or population growth-related encroachment by herders. These pressures are corroborated by the unclassified image, which shows scattered settlement patterns, uneven field patterns, and evidence of grazing and land conversion being visible. Such transitions in land cover, especially the encroachment of farmlands and residential areas, enhance land fragmentation and limit the free movement of livestock, elevating land use conflicts.

In Kanjo, the hotspots of conflict situations are observed along the cattle movement corridors, mostly in the southeastern part of the community. These regions exhibit frequent conflict areas as the animals walk through or beside operating farms. Some respondents identified the southeast region of the town as a hot spot. As one community leader explained, the cattle cross a stream, and some narrow paths are used with farmland, particularly around the local school and new residential development. Farmers complained of regular destruction of farms along the cattle trails to water points, especially in the dry season when feed becomes hard to come by, and the livestock are driven towards the outskirts of towns. Fulani pastoralists in Kanjo affirmed the non-existence of grazing corridors and that they have to "*go through farms to reach water*," which usually leads to conflicts with local farmers.

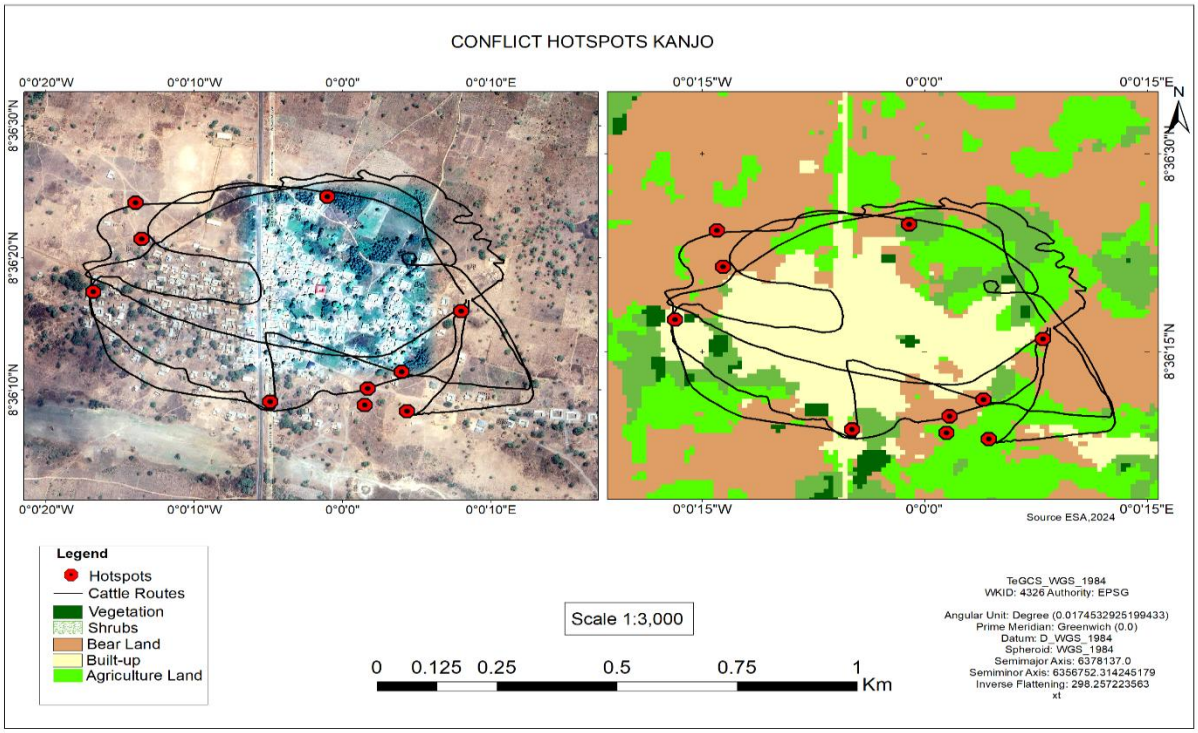

Figure 11: Conflict Hotspot of Kanjo

Figure 11 shows the spatial analysis of Kanjo, which reveals a dense clustering of conflict hotspots within a settlement area intersected by multiple cattle routes. The unclassified satellite image indicates a high level of urbanization, with several cattle paths weaving through built-up zones. The overlap between these routes and residential infrastructure contributes to repeated human-livestock interactions, which likely accounts for the high concentration of conflict points mapped in and around the town centre.

In the LULC-classified map, the core built-up area is surrounded by agricultural land, shrubland, and patches of bare land. The conflict hotspots are almost entirely located within or along the edges of built-up zones, with cattle routes extending into nearby agricultural lands and bare lands. This pattern suggests that Kanjo is experiencing a clash between urban expansion and traditional pastoral movement. As the town grows, space for free cattle movement becomes increasingly constrained, forcing herders to guide livestock through narrow or inappropriate urban corridors. This often results in property damage, blocked pathways, and tension with residents.

4.3.3. Buffer analysis of Conflict Hotspots and Cattle Routes

This analysis examines spatial conflict dynamics using 100-meter buffers around cattle routes and 50-meter buffers around identified conflict hotspots. In this analysis, using 100-meter buffers around cattle routes and 50-meter buffers around conflict hotspots is supported by standard GIS practices and aligns with the methodology in chapter 3.6. Buffering linear features like cattle routes at 100 meters effectively captures the immediate zone of potential interaction with surrounding land uses, such as farms and settlements. In contrast, 50-meter buffers around conflict hotspots provide a focused lens on the localized context of conflicts.

The Buffer analysis of conflict hotspots and cattle routes in Lungni, Gbungbaliga, and Kanjo communities. The maps display 100-meter buffers around cattle routes and 50-meter buffers around conflict hotspots, overlaid on high-resolution satellite imagery to highlight areas of spatial interaction, land use pressure, and potential conflict zones. In Lungni, the 100-meter cattle route buffer intersects farmland and vegetated zones, while 50-meter buffers around hotspots overlap with dispersed settlements and farm boundaries. The satellite image clearly shows patches of open land transitioning into cultivated plots, explaining why conflicts here are often tied to land conversion and contested use.

In Gbungbaliga, the cattle route buffer cuts through scattered farms and a water body, both visible in the basemap. The 50-meter buffers around hotspots tightly wrap around field margins and compound clusters, indicating friction at resource edges, particularly where livestock stray into croplands or compete for access to water. The satellite image shows dense urban development with little open space in Kanjo. The 100-meter cattle route buffers almost entirely encompass built-up areas, while the 50-meter conflict buffers overlap with homes, roads, and community institutions. This suggests high-intensity, recurring conflict due to a complete spatial collision between pastoral movement and residential life.

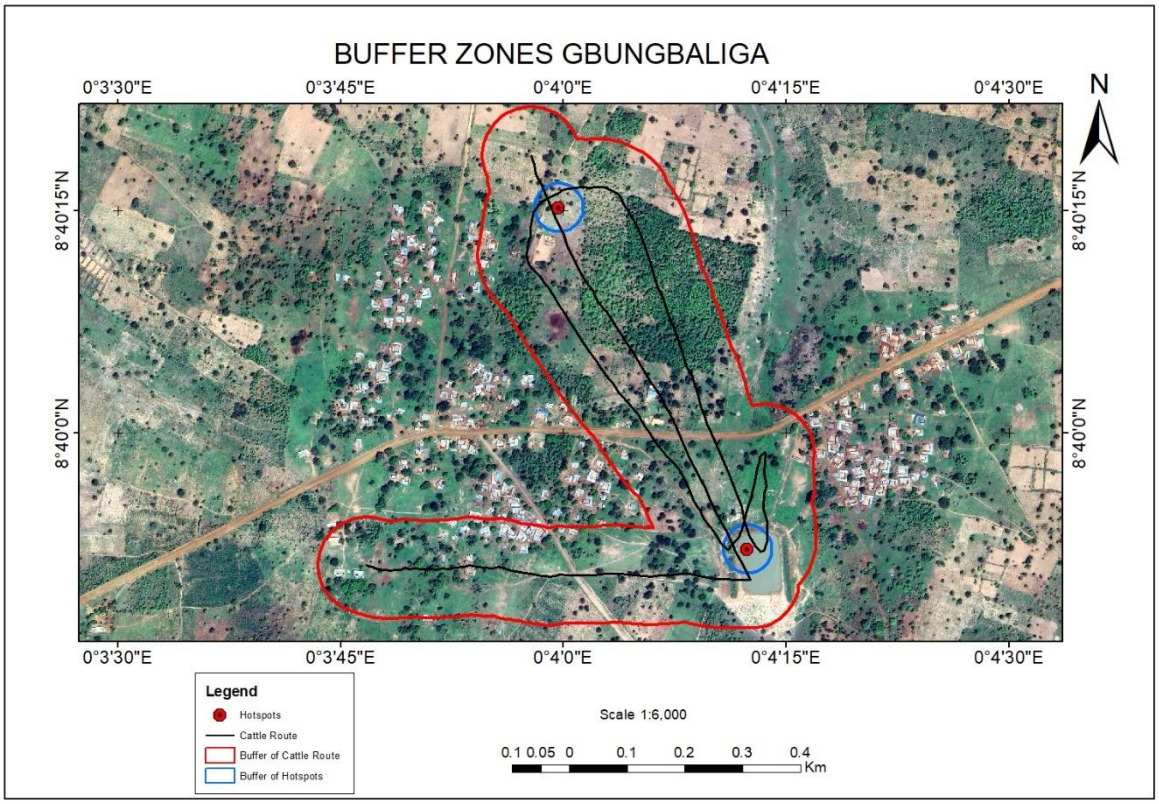

Figure 12: Buffer of Cattle Routes and Hotspots shown in Gbungbaliga

Figure 12 shows the delineated buffer zones surrounding cattle routes and conflict hotspots in Gbungbaliga. Corresponding maps for the remaining study communities are provided in Appendix 7.6 for comparative reference.

4.4. Comparative Analysis of Buffer Effects Across Communities

Across all three maps, one thing is consistent: the places where cattle move and people farm often overlap, and that is where most of the conflicts happen. The buffer zones drawn around cattle routes and hotspots help visualize the spaces where people, animals, and land use collide.

These spatial patterns match what was shared during focus groups and interviews: conflicts usually happen near farms, homes, and shared paths, and a lack of clear boundaries only worsens things (Field Data Collection). The lack of designated areas for grazing or movement increases the chances of accidental crop destruction and fuels community tensions and perceptions of encroachment. In this sense, spatial analysis adds visual confirmation to what participants described in their lived experiences.

Looking at the maps side-by-side makes it easier to see where solutions like designated grazing corridors, land zoning, or better communication could help reduce tension and improve relationships between herders and farmers. These patterns are not just technical outputs; they represent real-life social stress points where targeted interventions could improve coexistence between herders and farmers.

Table 3 presents a comparative summary of the buffer analysis conducted across all the study communities. It illustrates how the nature of conflict differs depending on land use intensity, population density, and spatial overlap, providing a clear basis for spatial interpretation and cross-community evaluation.

Table 3: Comparative Analysis of Buffer

Community	Cattle Route Buffer (100m)	Hotspot Buffer (50m)	Satellite Image Interaction	Conflict Characteristics
Lungni	Encloses transitional zones (farmland/vegetation)	Touches dispersed settlements and farms	Shows shattered land use; buffers align with contested boundaries	Landscape-scale, diffuse conflicts
Gbungbaliga	Intersects croplands and water bodies	Closely aligns with compound clusters	Clear visual overlaps with productive land and resource access points	Resource-based, localized conflicts
Kanjo	Covers the entire built-up area	Concentrated in high-density zones	Buffers are directly over residential and infrastructure	Acute, urban-pastoral tension

4.5. Comparing Conflict Hotspots Across Lungni, Kanjo, and Gbungbaliga

The conflict hotspot maps for Lungni, Kanjo, and Gbungbaliga offer a clear visual story of how land use tensions play out differently across the three communities, even though the underlying issues are often the same. To reinforce the reliability of the hotspots analysis, the defined spatial patterns were thoroughly checked against community-based data provided through participatory mapping activities and interviewing stakeholders. This integrated approach gave spatial precision and created a form of alignment between empirical GIS analysis and the lived events of pastoralists and farmers. The provided hotspot maps strongly represent land use conflicts, as the methodological triangulation allows the maps to be kept close to local realities.

In Lungni, most conflict hotspots are concentrated around farmland and the edges of residential areas. This spatial pattern aligns with what Dary et al. (2017) identify as a key trigger for conflict: the destruction of crops due to cattle straying into cultivated areas. The proximity of cattle routes to farmlands without designated boundaries worsens this issue. The localized nature of these conflicts supports findings from Nanii et al. (2024), who argue that land use conversion, especially in farming zones, leads to intense but spatially confined competition.

Kanjo shows a much more spread-out picture. There are several intersecting cattle routes that loop around the central part of the community, and conflict hotspots appear all along these paths. Compared to Lungni, Kanjo's conflict zones cover a wider area, which may reflect the higher number of routes or more seasonal cattle movement. The overlapping of grazing paths with farmlands and built-up zones adds to the everyday friction that farmers and herders in this area experience. This supports Otu & Sarfo's (2023) argument that

where clear land demarcation is absent, the mobility of pastoralists intensifies tensions, especially in settlements with expanding land frontiers.

In Gbungbaliga, the pattern is a bit different. The cattle routes and conflict hotspots are more concentrated in a single north-south corridor. Although the hotspots are fewer, they still sit within farming areas and close to residential settlements. One unique feature here is the presence of a water body and more shrubland, which likely affects where cattle pass through during different times of the year, a point reinforced by Nanii et al. (2024), who note that pastoral movements are frequently dictated by environmental conditions such as vegetation and water access.

4.6. Discussion of results for sub-objective three

This study reveals that land use conflicts in Lungni, Gbungbaliga, and Kanjo are spatially concentrated in areas where pastoral and farming activities overlap. Across all three communities, the absence of designated cattle routes and clear land-use zoning has led to informal movement patterns that intersect with farms, settlements, and water resources, consistently emerging as conflict hotspots. Spatial mapping, participatory data, and satellite imagery collectively show how physical geography and the lack of land management infrastructure converge to intensify farmer-herder tensions. These findings align with prior research highlighting poor land use planning as a core factor in agro-pastoral conflict (Turner, 2004; Ayantunde et al., 2011).

The results indicate that in Lungni, conflict zones are spread across transitional landscapes where farmland blends into shrubland and settlement edges. These are diffuse, often landscape-scale conflicts tied to land conversion and the lack of clear boundaries (Dary et al, 2017; Zhao & Jurdak, 2016). In Gbungbaliga, the pattern is more localized: conflict is focused on resource nodes like the dam, particularly during the dry season, when demand from herders and farmers intensifies. Kanjo, in contrast, displays concentrated conflict within built-up areas, where cattle movement now runs through dense residential zones due to urban expansion. The data reflect a more acute spatial collision between human settlement and pastoral activity.

Overlaying cattle route and hotspot buffers with high-resolution satellite imagery provides additional clarity. In Lungni and Gbungbaliga, the cattle route buffers frequently intersect with farmlands, water points, and open vegetation, indicating areas of direct interaction. In Kanjo, the buffers encompass nearly the entire town centre, aligning with reports of daily conflict and space compression caused by growing urban infrastructure.

However, these visual analyses also draw attention to the limitations of the ESA WorldCover (ESA-WLC) map used for land cover classification. While the ESA-WLC product performs well in mapping broad categories such as cropland, tree cover, and built-up areas (Xu et al., 2024), its 10-meter spatial resolution lacks the precision to detect small-scale landscape features. Comparisons with high-resolution base maps highlight key discrepancies; features such as narrow roads, clustered homes, or small gardens are often generalized or omitted.

Although it is suitable for analysis, it has some limitations that affect conflict analysis in heterogeneous zones, where mixed land uses are common. As Pontius and Clark (2007) argue, resolution mismatches introduce classification distortions, especially when coarse data are compared to high-detail imagery. Pixel-level disagreement may reflect data aggregation effects in these zones rather than fundamental land use differences. Temporal inconsistencies add another layer of complexity. The ESA-WLC dataset is fixed to

2021, while high-resolution basemaps may reflect more recent changes. Tsendbazar et al. (2021) emphasize that validation in such contexts must distinguish between legitimate land cover change and classification error to avoid bias.

Furthermore, ESA-WLC remains a valuable tool for broader spatial analysis. With an overall accuracy of 83.8% ± 0.4% (Xu et al., 2024), it effectively captures macro-scale patterns, particularly in rural or less fragmented regions. However, its performance diminishes in areas of high spatial complexity, such as rural Kanjo or irrigated zones in Lungni. In these contexts, high-resolution satellite imagery is essential, providing more precise visualization of contested boundaries and land-use transitions.

Moreover, the spatial and qualitative findings point to a shared structural issue across communities: a lack of land-use planning and regulatory frameworks. The likelihood of conflict remains high as cattle routes crisscross farms and settlements without formal guidance. Community members and law enforcement report that these hotspots repeat year after year, underscoring the systemic nature of the problem. Farmers-herder relations will remain vulnerable to disruption without interventions such as designated grazing corridors, participatory zoning, and coordinated land governance.

In conclusion, the conflict dynamics observed in Lungni, Gbungbaliga, and Kanjo are shaped by overlapping land uses, environmental pressures, and institutional gaps. While each community exhibits unique patterns based on settlement structure and land cover, the root causes are consistent competition for space and the absence of clear boundaries. A combination of high-resolution spatial analysis and locally grounded fieldwork has proven crucial in identifying these patterns and informing potential policy responses.

4.7. Chapter Summary

This chapter used qualitative field data and spatial analysis to examine land tenure systems, land use co-existence, and conflict dynamics in Lungni, Kanjo, and Gbungbaliga. Findings show that land access is governed by customary inheritance systems for indigenous families, while Fulani pastoralists depend on unstable, informal agreements. Awareness of national land policies is minimal, and coordination between traditional leaders and formal institutions remains fragmented. Land use conflicts, driven by crop destruction, lack of grazing routes, and overlapping claims, are concentrated in areas where mapped cattle paths intersect with farms and settlements. Integrating participatory mapping, hotspot analysis, and buffer zone models provides concrete spatial evidence of where and how these tensions manifest. Ultimately, the chapter reveals that tenure insecurity, weak institutional engagement, and the absence of land-use planning infrastructure are not only fuelling recurring conflicts but are embedded in the geography of the conflict itself.

5. LAND USE CONFLICT RESOLUTION

This chapter examines land use conflict resolution in the Nanumba South District, focusing on conflicts between farmers and pastoralists. While traditional mechanisms remain the primary resolution mode, an effective and agreed-upon way to resolve the recurring tensions and improve the resolution system is needed; hence, a practical and inclusive model for resolving land use conflicts must be developed.

5.1. Conflict Resolution Mechanisms and Perceptions of Land Use Co-existence

Conflicts over land, particularly between farmers and herders, are typically resolved through traditional conflict resolution mechanisms. Elders and chiefs mediate conflicts based on community memory, norms, and witness testimony. While most respondents expressed trust in these methods, some acknowledged recurring tensions when land is used for farming and grazing. In Kanjo, a few respondents suggested that government involvement might be beneficial in addressing issues such as land boundary conflicts and securing grazing corridors. One respondent noted, "*Sometimes, there are fights between farmers and herders. If the government helps us set boundaries, it will reduce problems*". In conflicts between farmers and pastoralists, both parties are summoned for dialogue and resolution, often culminating in the symbolic act of pouring water or offering a libation as a cultural ritual to reconcile the parties and seal the settlement. As one clan head in Lungni described, "*I call both sides together. Then I pour water to bless them and bring peace.*"

When issues of land use conflicts happen, assemblymen and clan leaders mediate and often require compensation for damaged crops. "*When there is damage, the Fulani pay. If they refuse, the farmer goes to the chief or the police,*" said a Kanjo assemblyman. Although community-based mediation is still the first step, respondents acknowledged it is becoming less effective under pressure. Police are involved when matters escalate. "*Most conflicts come to us when compensation is refused or the issue turns violent*," a police officer explained. However, pastoralists often avoid formal institutions due to fear and mistrust. As one herder in Lungni stated, "*People fear the police. We prefer to solve it with the elders.*"

In Kanjo, for instance, a community leader described a standard resolution process: "*We call both sides, listen to what happened, then ask the herder to pay. But it depends, sometimes people forgive if the damage is small*". This informality makes resolution flexible and opens space for perceived bias or injustice. When conflicts escalate or remain unresolved, they are brought to the police, who act as mediators. According to a police officer interviewed, the first step is to invite both parties to the station for dialogue. "*Most of the time, we resolve it here through agreement. But if the farmer insists, we go to the field and inspect the damage,*" he explained. Officers may involve agricultural extension agents to estimate crop losses in such cases. However, if negotiation fails, the case is referred to court, although few make it that far due to cost, delays, or social pressure to avoid litigation. In response to conflict resolution, one of the Lands Commission officers also pointed out that the lack of mapped boundaries and land use planning complicates the resolution. He said, "*We do not have defined grazing corridors, and the land is communally owned, which makes enforcement difficult.*"

5.1.1. Perspectives on Improving Land Use Co-existence

Respondents across the communities in the Nanumba South District offered a wide range of proposals for improving land use co-existence between pastoralists and non-pastoralists, reflecting both practical and collaborative approaches to address recurring conflicts. These suggestions emerged from farmers, herders, traditional leaders, community opinion leaders, the lands commission officials, and the police officer.

One prominent suggestion was the call for continuous education and sensitization, targeting pastoralists. A community leader in Lungni emphasized this need, stating, "*The Fulanis need to be educated. We need meetings where everyone, farmers, herders, chiefs, come together to agree*". For instance, a traditional leader proposed that these meetings could involve opinion leaders and religious bodies to counsel pastoralists on their responsibilities, noting, "*We try to share ideas, a common idea together, and see how the farmers will receive them, and they also take care of their cattle*". This approach is believed to be educative and, combined with dialogue, could bridge the gap between the two groups and reduce misunderstandings that often intensify conflicts between them.

Physical planning solutions also featured prominently among the recommendations. Respondents advocated establishing designated grazing areas and buffer zones to separate farmlands from grazing paths. An elder in Kanjo succinctly captured this idea: "*If the animals are controlled well and do not destroy crops, there will be no problem*". In a focus group discussion in Lungni, participants suggested that areas along streams, where small-scale farming occurs, could be reserved for grazing during specific periods, provided farmers agree to leave those zones fallow temporarily (Field Data Collection). Additionally, a respondent proposed reinforcing communal agreements to explicitly define land use rules, stating, "*The whole place has to be balanced so that the animals can move, and they can also farm*". Such measures aim to create spatial clarity and minimize the risk of livestock straying into cultivated areas.

Farmers emphasized the need for stricter land-use zoning to protect their livelihoods. Some recommended relocating herders to areas outside primary agricultural zones, especially during peak farming seasons when crops are most vulnerable. A farmer lamented the destruction caused by cattle, noting, "*This year, she could not have cassava because the cows destroyed everything,*" and suggested that herders be given distinct spaces to avoid such losses. Similarly, in Kanjo, a focus group participant proposed, *"They should get a place for them and their cattle so that I can also farm my own land*", highlighting the desire for physical demarcation to ensure peaceful land use co-existence. This call for separation was not limited to farmers; pastoralists themselves expressed a need for designated grazing spaces, with one herder noting, "*If they allow us to use land that they are not farming, there will be no problem*", indicating a mutual interest in defined boundaries.

Traditional leaders offered additional strategies, including introducing written agreements when receiving pastoralist groups. A leader in Kanjo explained that such agreements could outline rights, responsibilities, and consequences for violations, providing a formal framework for accountability. "*When they come, we give them the rules*," a community leader stated, adding that compliance ensures peaceful stays, while breaches might require compensation or expulsion. Another traditional leader in Gbungbaliga suggested "*integrating traditional practices, such as pouring libations to bless land allocations, with modern documentation to solidify these arrangements*". These proposals reflect a blend of customary authority and practical land administration, enabling more effective land allocation and land use regulation.

The police officer provided a law enforcement perspective, emphasizing physical and supervisory measures to curb conflicts. He noted, "*We have noticed that animals are often left in the care of children. They are not attentive. If adults manage the grazing, there would be fewer problems*". He advocated for better fencing of farmlands to protect crops and stricter oversight of livestock movement, particularly by capable herders rather than minors. Additionally, he emphasized the importance of logistical support, including transportation and mobile communication tools, to facilitate rapid responses to conflicts in remote areas. "*If we had the means to reach these places quickly, we could intervene before things escalate,*" he noted.

From an institutional perspective, government officials from the Land Commission accentuated the critical role of spatial data and policy frameworks in promoting peaceful land use co-existence. One suggested that preparing detailed cadastral plans and lease documents for pastoralists, specifying their activity boundaries

and duration, could prevent conflicts by clarifying limits. "*They should be given some simple map or plan that shows the limit of their boundary so that when they are moving, they know the extent to which they have to do their daily activity*," he explained. He further advocated for enhanced collaboration between the Land Commission and traditional authorities through stakeholder consultations involving agencies like the Survey and Mapping Division, the Ministry of Agriculture, and the Forestry Commission. This approach, he argued, would ensure equitable land allocation and reduce conflicts by integrating community input with technical expertise, addressing gaps such as poor boundary demarcation that often fuel tensions (Field Data Collection).

Beyond these specific measures, respondents emphasized the importance of collaboration across stakeholders. During a focus group discussion in Lungni, they advocated forming a committee to oversee land use affairs, integrating traditional practices, government policies, and community initiatives. "*We have to form a committee that will look into the affairs of the animals and the farm work*," another respondent advocated involving police and district authorities in these discussions to lend weight to resolutions, stating, "*We try to invite policemen among us and send a report to the district chief*". Finally, respondents tied land use co-existence to broader community needs, such as access to water resources. A participant in a focus group discussion requested, "*We do not have enough water, especially in the dry season. If you know a way to help us get enough water, it would reduce problems with animals*". This suggestion highlights how environmental factors also influence land conflicts.

5.2. Land Use Conflict Resolution Model Development

The land use conflict resolution model developed in this study is grounded in participant responses presented in the findings addressed in Section 4 and the perspectives on improving land use co-existence discussed in Section 5.1. While existing mechanisms for resolving conflicts are in place, the findings highlight the need for a more structured and practical model that enhances conflict resolution and supports improved livelihoods within the communities. The development draws from the Lincoln Institute of Land Policy's framework for integrating mediation into land use decision-making processes. The model emphasizes the role of Alternative Dispute Resolution (ADR) techniques, particularly mediation, as tools to mitigate conflicts and build consensus in contested land use settings (Lincoln Institute of Land Policy, 2010). Similarly, the model incorporates insights from Agegnehu et al., (2021), whose research on land tenure security in Ethiopia highlights the effective combination of traditional mechanisms, such as customary authorities, with formal state-based legal processes.

Building on these foundational models, the model developed here introduces a systematic and context-responsive progression from initial conflict identification to resolution and post-agreement reinforcement. The integration of traditional mediation (e.g., elders and libation rituals), formal advisory bodies (e.g., government land commissions and GIS tools), and ADR strategies (e.g., satellite imagery and independent mediators) reflects a deliberate effort to tailor conflict resolution methods to the sociopolitical and environmental landscape. Once agreements are achieved, the model advances into structured Land Use co-existence mechanisms, including participatory land use zoning, shared resource agreements, land use contracts, and community education. This multi-pronged strategy enhances legitimacy, ensures sustained compliance, and aims to reduce conflict, improve livelihoods, and strengthen stakeholder trust.

Figure 14 is the developed model for this research, which will resolve land use conflicts, improve people's lives in the Nanumba South District of Ghana, and enhance land use co-existence.

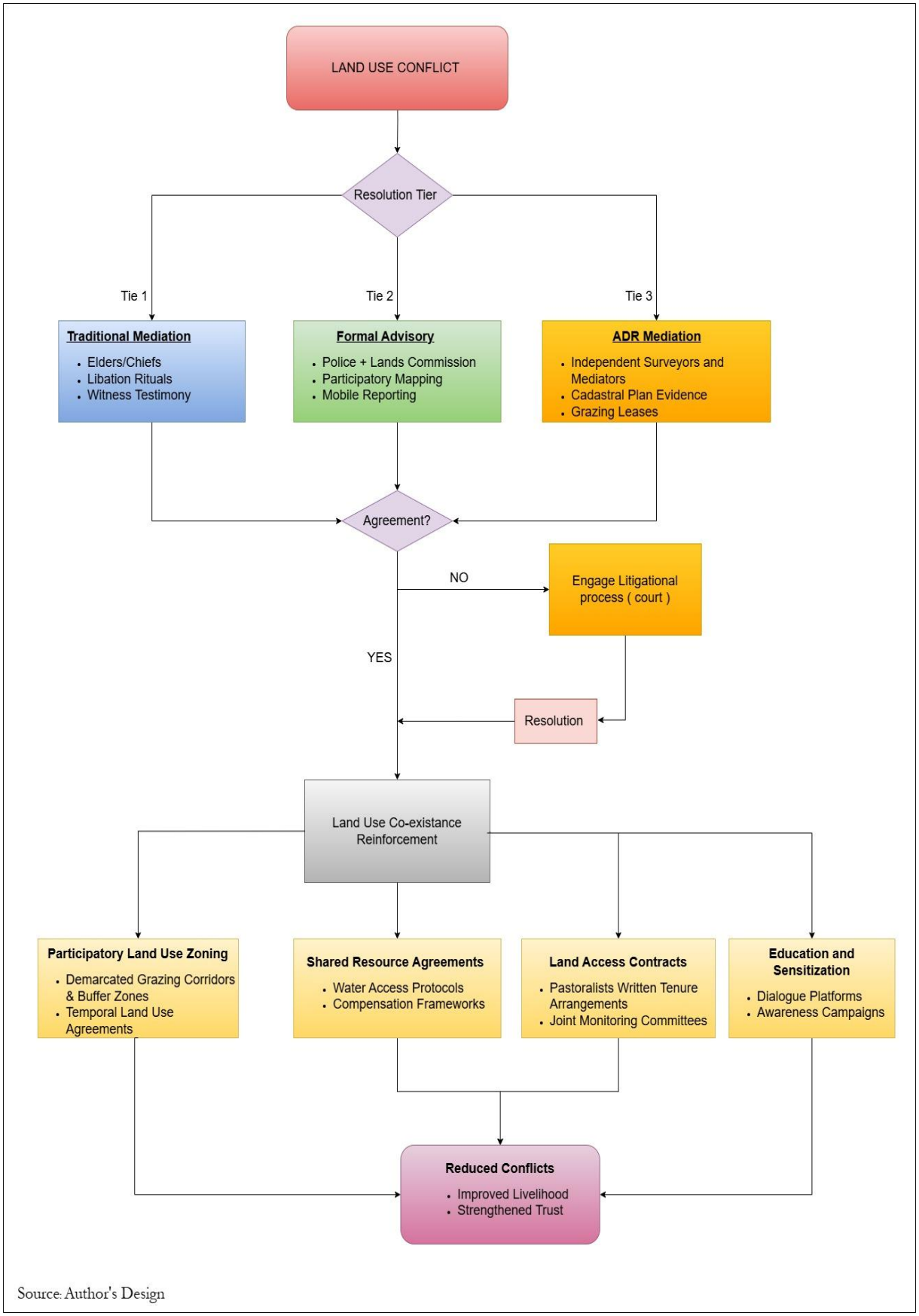

Figure 13: A multi-tiered model for resolving land use conflicts

The inclusion of ADR in the proposed model was informed by the observation that many community members lacked awareness of its principles and practices. As discussed in Section 2.4.2, ADR is increasingly being institutionalized within Ghana's land administration systems, and its integration at the community level is timely and necessary. Embracing ADR within local conflict resolution processes offers a structured, culturally compatible approach to enhancing fairness, reducing tensions, and building trust among land users.

5.3. Validation of a multi-tiered model for resolving land use conflicts

The strength and relevance of the developed model are validated through a convergence of field evidence, scholarly frameworks, and grounded contextual understanding developed over the research period. First, the model was not externally imposed but shaped by the lived experiences of pastoralists, farmers, and local leaders in Nanumba South. Their voices highlighted deep dissatisfaction with uneven conflict resolution efforts and a strong preference for integrated, culturally sensitive mechanisms, insights that are directly embedded in the model's structure. Secondly, the model aligns with broader literature advocating for hybrid governance systems. Scholars such as Herrera et al. (2014) and Mwangi & Ostrom (2009) argue that land use co-existence is most sustainable when diverse tenure systems are harmonized, and participatory governance structures are empowered to manage shared resources. However, the inclusion of ADR, despite current low awareness among local communities, follows this logic; it serves not as a foreign imposition but as a bridge between local norms and formal institutions, echoed by Ibrahim et al. (2022), who emphasize the growing role of ADR in Ghana's rural land administration.

Finally, this model is a product of sustained field involvement. Through interviews, focus group discussions, participatory mapping, and daily interactions, I understood the institutional gaps and the informal strategies already used for conflict resolution. These realities shaped the model's tiered approach, ensuring it is theoretically sound and pragmatically attuned to the district's socio-political landscape. As such, the model reflects both academic accuracy and community-rooted insight, designed not just to resolve conflicts but to restore trust, clarify roles, and support equitable land use into the future.

5.4. Chapter Summary

This chapter discusses land use conflict resolution in the Nanumba South District, focusing on disputes between farmers and pastoralists. Traditional systems led by chiefs, elders, and local leaders remain widely used, relying on dialogue, cultural rituals, and community memory. However, unclear land boundaries, recurring tensions, and limited enforcement capacity increasingly challenge these mechanisms. While the police are sometimes involved, formal processes are often avoided due to fear, cost, or mistrust. To address these gaps, respondents proposed practical strategies such as designated grazing corridors, buffer zones, written agreements, education, and improved coordination between stakeholders. Based on these insights, the study developed a context-specific land use conflict resolution model. The model integrates traditional mediation, formal advisory support, and Alternative Dispute Resolution (ADR) mechanisms, progressing toward improved land use co-existence and reducing conflict in the Nanumba South District.

6. CONCLUSIONS AND RECOMMENDATIONS

This chapter presents the main conclusions drawn from the research, organized according to the four objectives of the study. It combines the key findings, reflects on their implications, and offers practical recommendations. The chapter also outlines the study's limitations and proposes directions for future research.

6.1. Objective 1: Explore the current land tenure arrangements in Nanumba South District.

It was found that in the Nanumba South District, people's access to land is mainly influenced by their cultural customs. Land tenure is typically handed from one generation to the next in farming families; it is valued more for its cultural meaning than for how much it can be sold. After discussing this in Chapter 4.1, we see that this system of land tenure arrangement makes it possible for non-pastoralists to keep using the land securely, even though they lack formal documentation.

Unlike other groups, like farmers, the story for pastoralists, such as Fulani herders, is unique. Receiving land is done unofficially and undocumented, and their land usage is for a short while, usually relying on agreements made with the local chiefs or owners. Because these arrangements are simple to revoke, pastoralists no longer have the right to the land they depend on under the law or tradition. Because they do not always own land, pastoralists are easily impacted by conflicts over resources, a significant source of tension within the communities.

6.2. Objective 2: Examine the interactions of land use co-existence and conflicts between pastoralists and non-pastoralists

The results highlighted in Chapter 4.2 that land conflict in the district arises from farms being visited by straying livestock, unclear cattle paths, and disagreements over resource use. However, these physical factors are closely linked to social issues, such as past grievances and group inequality. Viewing pastoralists as outsiders who cannot settle down permanently aggravates the problem.

Additionally, it was found that while people still use traditional methods to resolve conflicts, these approaches are not always perceived as fair or inclusive. Generally, pastoralists feel overlooked during these important processes. This research emphasizes that it is achievable for Nanumba South to be at peace, but it needs a structure to improve land use co-existence. For pastoralists to survive and settle in the communities, they need guidance, special grazing paths, continuous and improved education through community engagement, to be seen as part of the community's residents, and to engage in the land use co-existence process.

6.3. Objective 3: Map conflict hotspots within the study area based on the spatial relationship between cattle routes, Land Use types, and reported conflict areas.

Building on the findings from Objective 2, the study identified critical conflict hotspots where cattle routes intersect with farmlands and settlements through participatory mapping and GIS analysis (Chapter 4.3). For example, buffer analysis and spatial overlays revealed repeated overlap between informal grazing paths and areas of intensive crop cultivation, particularly in Lungni and Gbungbaliga. These overlaps aligned with field reports of frequent tensions and incidents of conflict.

In all the communities, frequent overlaps of grazing paths with active farms were consistent with their land-use land cover data, and as shown with the satellite imagery, which is a trigger of conflict as reported by respondents (Chapter 4.3). Maps created with the data showed where the worst conflicts happened and helped plan important interventions. Using data from the community and spatial techniques made the research findings stronger and more relatable. It also proved that participatory GIS could link professional planning to the knowledge held by local people, which is key for designing equitable land use rules.

6.4. Objective 4: Develop a practical model that strengthens land use co-existence between pastoralists and non-pastoralists in Nanumba South District.

Chapter 5 of this research focused on understanding existing conflict resolution mechanisms and testing the feasibility of a practical land use co-existence model. The study found that while traditional mechanisms such as arbitration by chiefs and community elders exist, they are often inconsistent and perceived as biased, particularly by pastoralist groups. These mechanisms also lack formal backing, limiting their authority and sustainability in recurring conflicts (Chapter 5.1).

In response, a stakeholder-informed co-existence model for conflict resolution was developed (Chapter 5.3). The model development took insights from the results of earlier objectives in (Chapter 4) and used them to design a practical model to resolve conflicts and improve land use co-existence. The people want fairness, transparency, and representation in conflict resolution. The model developed in this study includes those elements and builds on what already exists in the communities, but adds structure, inclusivity, and spatial clarity.

The model includes participatory mapping, demarcation of shared land use zones, joint conflict resolution committees, and formal recognition of grazing corridors. It considers the community's needs, matches the needs of those who use the land, and offers a flexible method to improve the welfare of people, the environment, and the relationships of the people.

6.5. Limitations of the Study

Although this research provides meaningful insights into land use co-existence and conflict in the Nanumba South District of Ghana, it is important to acknowledge some limitations.

First, the geographic scope of the study was limited to three purposively selected communities: Lungni, Kanjo, and Gbungbaliga. These were chosen for their representativeness of farming and pastoralist interactions. However, they do not reflect the full diversity of land tenure arrangements and land use conflicts within the wider Nanumba South District. Land administration practices and conflict drivers may differ significantly across districts, influenced by ethnic composition and local leadership structures.

Secondly, time and resource constraints limited the depth of engagement and extensive observation. Data were collected at a single fieldwork window, restricting the ability to observe seasonal migration, delayed conflict resolution dynamics, or evolving land use patterns over time. This is particularly relevant given that land use tensions often increase or subside depending on agricultural cycles and climatic conditions.

Another prominent limitation with using ESA WorldCover is that it does not match the same time or space scales as the satellite data it comes from. Looking closely at two images is unnecessary since comparing them across the entire image covers the same idea. Pontius and Cheuk (2006) argue that making comparisons

among different resolutions tends to result in misleading information about classification accuracy. Additionally, because ESA-WLC is based on 2021 observations, any recent land cover change in base maps (e.g., post-2021 urban expansion or seasonal vegetation shifts) will not be captured. Tsendbazar et al. (2021) caution that temporal mismatches, if unaccounted for, can introduce systematic errors during validation and interpretation. Although ESA-WLC is one of the most accurate GLC products currently available (Xu et al., 2024), its resolution, class definitions, and classification model inherently favor generalized over detailed spatial representation. Therefore, it is better suited to regional or continental-scale land cover analysis than local precision mapping.

Finally, this study did not specifically address the struggles women face in engaging actively with land use issues and conflict resolution processes. However, previous research has identified significant gendered barriers, particularly within pastoralist communities (Yiampoi, 2014). Despite some women contributing to the data collection process, their representation was limited, with only a small number participating in interviews and focus group discussions. This limitation reflects broader patterns of women's exclusion from decision-making roles at the community level, posing a challenge to the comprehensiveness of this study's findings.

6.6. Recommendations and Areas for Further Research

Even though the study had its limitations, as mentioned in Chapter 6.5, it developed a conflict resolution model that will significantly improve the lives of the people in the communities.

We recommend implementing and testing the land use conflict resolution model developed in this study with close cooperation among local authorities, traditional leaders, and community people. Simple yet effective systems, such as participatory mapping, setting land use areas, and consistent conflict resolution committees, suit the requirements in the Nanumba South District. The model should be tested in a pilot program in selected places to check whether it is reliable and works effectively.

Success in using this model will come from capacity building, defining each institution's role, and regularly engaging with the community to ensure it is respected and uses more flexible, inclusive approaches. According to Chapters 4 and 5.1 findings, people who use land in the Nanumba South District, especially the study communities, often do not understand Alternative Dispute Resolution (ADR) processes well. For this reason, it is important to integrate ADR training and awareness as part of capacity building into the implementation process to enhance local conflict resolution skills. Applying the model in district and regional land administration posts can help achieve lasting solutions to land use conflicts, share land access more fairly, and improve community earnings.

To build on this study, future research could focus on:

- Scaling up the research to diverse geographical locations to test the developed model's adaptability within land use and conflict contexts.
- Explore how the limited policy awareness, land access, and tenure insecurity disproportionately affect women among pastoralist and non-pastoralist groups.
- Assessing the role of participatory land use planning in reducing land use conflicts and enhancing agricultural productivity at the community level.

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7. APPENDICES

7.1. Appendix 1: Research Design Matrix

Research Question	Data Required	Source of Data	Data Collection Method	Analysis Method	Respondents	Anticipated Results
Objective One: Explore the current land tenure arrangements in Nanumba South District.						
a. What is the current policy on land administration in the Nanumba South District?	Information on land management policies, regulations, and customary rules.	Government documents, local land records, and interviews with authorities.	Literature review, semi-structured interviews	Content analysis/ Thematic analysis	Government officials, land management authorities	Overview of existing land management policies and framework.
b. What is the customary land tenure arrangement in the Nanumba South District?	Customary land practices and usage rights.	Local community records and interviews with chiefs and landowners.	Semi-structured interviews, focus group discussions	Thematic analysis	Chiefs, local community leaders, landowners	Insights into customary land tenure arrangements.
c. What policy affects the land use arrangements of pastoralist and non-pastoralist users?	Data on how policies apply to land allocation and use for different user groups.	Policy documents, interviews with pastoralists and non-pastoralists.	Semi-structured interviews, focus group discussions	Thematic analysis	Pastoralists, non-pastoralists, community leaders	Understanding of policies shaping land use for different groups.
Objective Two: Examine the interactions of land use co-existence and conflicts between pastoralists and non-pastoralists.						
a. What factors contribute to land use co-existence and conflicts between pastoralists and non-pastoralists in shared environments?	Data on interaction dynamics between groups.	Field observations, local reports, and interviews.	Semi-structured interviews, observations	Thematic analysis	Pastoralists, non-pastoralists, local leaders	Understanding of factors leading to land use co-existence or conflict.

b. How does competition over resources and land use shape the interactions between pastoralist and non-pastoralist communities?	Resource availability, land competition data.	Local land use data, interviews, focus groups.	Focus group discussions, semi-structured interviews	Thematic analysis	Farmers, pastoralists, land management authorities	Insights on resource-based conflicts.
c. What strategies or mechanisms have effectively promoted peaceful land use co-existence between pastoralists and non-pastoralists?	Existing land use conflict resolution mechanisms and cooperation practices.	Land use conflict resolution records, interviews with mediators.	Semi-structured interviews, community discussions	Thematic analysis	Community leaders, mediators, pastoralists, non-pastoralists	Identification of effective land use conflict resolution strategies.
Objective Three: Map conflict hotspots within the study area based on the spatial relationship between cattle routes, Land Use types, and reported conflict areas.						
a. Where are the primary cattle routes located, and how do they intersect with other land use types?	Spatial data on cattle routes and land uses.	GIS data (sentinel data), cattle routes maps (Ministry of Agriculture, Veterinary services).	Spatial mapping, observations.	Spatial analysis.		Map of cattle routes and intersecting land uses.
b. Which areas in Nanumba South District experience the most frequent land-use conflicts?	Reports of land conflicts and hotspot data.	Local records, police reports, interviews.	Semi-structured interviews, spatial mapping.	Conflict analysis, GIS overlay.	Pastoralists, non-pastoralists, local authorities	Identification of conflict-prone areas.
c. What spatial patterns are evident between conflict areas and specific land uses (e.g.,	Spatial relationship data between conflict areas and land use types.	Field reports, land use conflict records, GIS data (sentinel data).	GIS analysis, interviews.	Pattern analysis, Spatial mapping.		Insights into spatial patterns of land use conflicts.

farming, residential areas)?						
Objective Four: Develop a practical model that strengthens land use co-existence between pastoralists and non-pastoralists in Nanumba South District.						
a. How will stakeholder perspectives be integrated into a model that promotes land use co-existence?	Data on stakeholder needs and perspectives	Focus groups, interviews	Focus group discussions	Model development	Stakeholders, community representatives	A model integrating stakeholder perspectives
b. How can the hotspot map be used to validate the proposed model by identifying conflict-prone areas and testing the model's effectiveness in reducing tensions?	GIS hotspot data, stakeholder feedback on conflict	Hotspot map (GIS data), conflict hotspots identified through spatial analysis, stakeholder feedback	GIS spatial analysis, case studies in hotspot areas	Spatial correlation, case study analysis	Local leaders, stakeholders in hotspot areas	Validation of model effectiveness in reducing conflict in high-risk areas; feedback for model refinement
c. What strategies can be proposed to improve land use co-existence between pastoralists and non-pastoralists?	Data on best practices and strategies for land use management	Literature review, expert consultations	Literature review, interviews	Policy recommendation	Experts, community leaders	Proposed strategies for land use co-existence

7.2. Appendix 2: Required Tools and Materials

Tool/Material	Description	Relevance	Status
Geographic Information System (GIS) Software	Software for spatial analysis and mapping of land cover patterns.	Essential for analyzing spatial data, visualizing LC changes, and mapping conflict hotspots.	Required; available through institutional licenses (e.g., ArcGIS) or open-source options (e.g., QGIS).
Remote Sensing Tools	Tools for processing satellite imagery (e.g., Landsat, Sentinel).	Critical for analyzing satellite imagery, generating LC maps	Required; available as free online tools (e.g., Google Earth Engine).
Survey Instruments	Questionnaires, interview guides, and focus group discussion protocols for gathering qualitative data.	Collecting primary data on land tenure, conflict interactions, and co-existence strategies.	Required; will be developed specifically for the fieldwork phase of the research.
Qualitative Analysis Software	Software used for analyzing survey data.	Needed for analysis of survey responses.	Required, available through institutional licenses. (e.g., Atlas.ti)
Audio and Video Recording Equipment	Devices for documenting interviews, focus groups, and conflict resolution sessions.	Essential for capturing qualitative data during fieldwork and documenting conflict resolution practices.	Required; available for rent or institutional use.

7.3. Appendix 3: Data Management Plan

Category	Details
Types of Data Collected	- Interview and FGD audio recordings and transcripts- Field notes- Annotated participatory maps- GIS layers (cattle routes, hotspots)- Satellite imagery and LULC data
Data Collection & Documentation	- Interviews transcribed using TurboScribe and coded in ATLAS.ti- Participatory maps scanned, georeferenced in ArcGIS- Metadata created for geospatial layers
Storage and Security	- Digital data stored on a password-protected laptop and encrypted external drive- Physical notes and maps stored in a locked cabinet- Transcripts anonymized and coded
Ethics and Consent	- Verbal/written informed consent obtained in local languages- Ethics approval secured from University of Twente (Approval No. 241136)- Participants de-identified in all outputs
Data Sharing and Access	- Raw qualitative data (e.g., transcripts) will not be publicly shared due to sensitivity- Processed GIS layers may be shared with ethics clearance- Maps may be published in reports or articles
Preservation and Retention	- Data retained securely for at least 5 years- Key outputs (maps, visualizations) archived for long-term academic and policy use
Software Used	- ATLAS.ti for qualitative coding- ArcGIS 10.8.2 for spatial analysis- TurboScribe for transcription- Excel, Word, Adobe Scan for documentation and processing

7.4. Appendix 4: Interview Questions and Focus Group Discussion (FDGs) Questions

Interview Questions and Focus Group Discussion (FDGs) Questions

Key Interview Questions for Stakeholders

Questions for Chiefs, Traditional Leaders, and Community Leaders

Objective 1: Explore current land tenure arrangements.

1. Do you allocate land based on customary practices?

   Yes / No
2. How is land allocated under customary practices in your community? *(Personal experiences).* (in 5 minutes)
3. How is land managed under customary practices in your community? *(Personal experiences).* (in 5 minutes)
4. What role do you play when it comes to Land use arrangements as Chiefs, Traditional Leaders, and Community Leaders?
5. Do these rules differ for pastoralist and non-pastoralist land users?
6. What traditional rules regulate land allocation to pastoralists and non-pastoralists in the community?
7. Are there specific rules that give rights of ownership to pastoralists and non-pastoralists, given a brief explanation? (in 5 minutes)
8. *Follow-up*: Can you explain how these rules are enforced or challenged? (in 5 minutes)
9. Are you familiar with government policies governing land administration?

   Yes / No
10. *Follow-up*: How are these policies applied, or do they conflict with traditional practices? (in 5 minutes)
11. How do traditional systems interact with government policies on land administration?
12. *Follow-up*: Are there specific challenges or areas of collaboration with government policies? (in 5 minutes)

Objective 2: Examine land use co-existence and conflicts

1. How would you describe the relationship between pastoralists and non-pastoralists in your community? (in 5 minutes)
2. Have you mediated conflicts between pastoralists and non-pastoralists? Yes / No
3. If yes, what were the causes and outcomes? (in 5 minutes)
4. What are the most common causes of conflicts over land use in your community?
5. *Follow-up*: How have these causes evolved over time? (in 5 minutes)
6. How do you resolve land-use conflicts between pastoralists and non-pastoralists? (in 5 minutes)
7. What traditional practices or mechanisms exist to resolve land-use conflicts?

8. How effective are these mechanisms or practices from your perspective? (in 5 minutes)
9. What do you think could improve land use co-existence between pastoralists and non-pastoralists in the community?

Objective 3: Map conflict hotspots

1. Are there specific areas within your community where conflicts over land use occur frequently? Yes / No
2. *Follow-up*: What makes these areas prone to conflicts? If yes? (in 5 minutes)
3. Can you identify these areas on a map or describe them?
4. What land use categories (e.g., farming land, grazing land, residential land) are most associated with conflicts in these areas?

Objective 4: Develop a practical model

1. Should traditional practices be integrated with government policies to manage land use conflicts?

   Strongly Agree / Agree / Neutral / Disagree / Strongly Disagree
2. What steps do you think are necessary to improve land use co-existence between pastoralists and non-pastoralists in your community? (in 5 minutes)
3. What strategies or traditional practices do you think could be integrated into a model for peaceful land use? (in 5 minutes)
4. Are you open to participating in initiatives that promote land use co-existence? Yes/No
5. If yes, how do you want to do that? (in 5 minutes)
6. If no, why so?

Questions for Police Officers and Security Personnel

Objective 2: Examine land use co-existence and conflicts

1. What land-related conflicts are most frequently reported to your station between pastoralists and non-pastoralists?

   - ✓ Grazing on farmland
   - ✓ Land boundary
   - ✓ Water resource access
   - ✓ Destruction of crops by livestock
   - ✓ Encroachment on residential areas
   - ✓ Conflicts over cattle routes
   - ✓ Other (please specify and elaborate)
2. How does your station handle land conflicts between pastoralists and non-pastoralists in this area? (in 5 minutes)
3. *Follow-up*: Are there specific policies or protocols guiding your actions? (in 5 minutes)
4. How do you collaborate with traditional authorities and government agencies to resolve land conflicts between pastoralists and non-pastoralists? (in 5 minutes)

5. Do conflicts over land use occur more frequently during specific seasons?

   Yes / No

6. If yes, which season?
   a) Dry Season
   b) Wet Season
   c) Year-round
7. From your experience, what are the leading causes of land-use conflicts between pastoralists and non-pastoralists? (in 5 minutes)
8. What has been your experience with conflict resolution? (in 5 minutes)
9. What strategies have been most successful? (in 5 minutes)

Objective 3: Map conflict hotspots

1. Can you identify specific areas within the community that frequently experience land-use conflicts?
2. Based on your records, what makes these areas prone to conflict?
3. Are there any groups or activities that tend to be involved in these conflicts aside from pastoralists and non-pastoralists?

Objective 4: Develop a practical model

1. What role do you think security agencies can play in promoting peaceful land use co-existence? (in 5 minutes)
2. *Follow-up*: What additional support or resources would help you manage these conflicts more effectively?
3. Do you have recommendations for reducing land-use conflicts between pastoralists and non-pastoralists in these areas? (in 5 minutes)

Questions for Lands Commission Officers and Government Officials

Objective 1: Explore current land tenure arrangements

1. What policies and frameworks guide land allocation for pastoralists and non-pastoralists in the Nanumba South District?
2. How does your office collaborate with traditional authorities in land administration?
3. *Follow-up*: Are there gaps in this collaboration? (in 5 minutes)
4. Are there any policies that hinder or support equitable access to land for different user groups? (in 5 minutes)
5. What specific challenges are there in implementing these policies at the local level? (in 5 minutes)

Objective 2: Examine land use co-existence and conflicts

1. Do current land policies address the needs of both pastoralists and non-pastoralists? Strongly Agree / Agree / Neutral / Disagree / Strongly Disagree
2. *Follow-up*: Why or why not?

3. What do you think are the main factors contributing to conflicts between these groups? (in 5 minutes)
4. Are there existing mechanisms within the policy framework to promote peaceful co-existence? Yes/No
5. If yes, how effective are they?
6. If no, explain.

Objective 3: Map conflict hotspots

1. Does the Lands Commission have spatial data (e.g., maps) showing how land is used in this district? Yes/No
2. *Follow-up*: How is this data used to address land-use conflicts?
3. How can spatial data, such as maps of cattle routes and land use, help in managing land conflicts?
4. Are there areas you would identify as conflict hotspots based on the data you have?

Objective 4: Develop a practical model

1. What policies or practices could be introduced or improved to promote peaceful land use co-existence between pastoralists and non-pastoralists?
2. How can the Lands Commission support stakeholders in managing land conflicts more effectively between pastoralists and non-pastoralists?

Questions for Pastoralists

Objective 1: Explore current land tenure arrangements

1. How do you access and own land for grazing in the community? (in 5 minutes)
2. Do you face challenges accessing grazing land? Yes / No
3. *Follow-up*: What are the specific challenges you face?
4. Are you aware of any policies or customary rules governing your land use? (in 5 minutes)
5. *Follow-up*: do you know how well these policies are enforced in the community? (in 5 minutes)

Objective 2: Examine land use co-existence and conflicts

1. How would you describe your relationship with non-pastoralists in this area? (in 5 minutes)
2. What are the primary sources of conflict between your group and others?
3. *Follow-up*: How have these conflicts affected your activities? (in 5 minutes)
4. How are these conflicts usually resolved? (in 5 minutes)
5. *Follow-up*: What strategies work best?

Objective 3: Map conflict hotspots

1. Are there specific areas where you have experienced conflict with farmers or other land users?
2. Are you aware of the existing cattle route in the community?

3. What are the routes you use for cattle grazing? Can you show me on the map?
4. *Follow-up*: Can you identify these areas prone to conflicts? *(Mark on the map if possible.)*
5. What makes these areas problematic?
6. Do these conflicts occur regularly, or are they seasonal?

Objective 4: Develop a practical model

1. What changes or support could improve your relationship with non-pastoralists in this community?
2. Are you willing to participate in initiatives that promote peaceful land use and land use co-existence? Yes/No
3. If yes, how will you do that?
4. If no, why so?

Questions for Non-Pastoralists (Farmers)

Objective 1: Explore current land tenure arrangements

1. How do you access and manage land for your farming activities?
2. iAre there specific challenges you face due to pastoralist activities? Yes/No
3. If yes, what are your challenges?
4. Are there any policies or rules that affect your use of land? Yes/No
5. If yes, what are they?
6. If no, why so?

Objective 2: Examine land use co-existence and conflicts

1. What is your relationship like with pastoralists in this area?
2. What are the primary sources of conflict with pastoralists?
3. How do these conflicts impact your livelihood?
4. *Follow-up*: Have there been successful resolutions? If yes, what made them effective?
5. In your opinion, what could be done to improve peaceful land use co-existence?

Objective 3: Map conflict hotspots

1. Are there areas in your community where conflicts with pastoralists are more likely to occur?
2. Where are these areas prone to conflicts? *(Mark on the map if possible.)*
3. Do these conflicts affect your livelihood?

Objective 4: Develop a practical model

1. What strategies do you think would help improve land use co-existence in this community?
2. Are you willing to participate in initiatives that promote peaceful land use and land use co-existence? Yes / No

3. If yes, how will you do that?
4. If no, why so?

Key FGD Questions

FGDs with Chiefs, Traditional Leaders, and Community Leaders

1. How does customary land tenure regulate land use in this community?
2. What are the shared challenges in managing land for pastoralists and non-pastoralists?
3. Using this map, can we identify areas prone to conflicts and why they are problematic?
4. What traditional conflict resolution mechanisms exist, and how effective are they in resolving these land conflicts?
5. What strategies could improve relationships between different land users?

FGDs with Pastoralists

1. What challenges do you face when accessing grazing lands in this community?
2. How do you interact with non-pastoralists, such as farmers or residents?
3. What are the leading causes of conflicts over land use in your experience?
4. What strategies or practices have helped reduce conflicts with non-pastoralists in the past?
5. What suggestions do you have for improving relationships and co-existence with non-pastoralists?

FGDs with Non-Pastoralists (Farmers, Residents, etc.)

1. What challenges do you face in using land for farming or other activities in this community?
2. How do pastoralists' activities affect your land use in the community?
3. How do you currently interact with pastoralists in the community?
4. What are the primary sources of tension or conflict with pastoralists?
5. Are there specific areas or times when conflicts are more likely to occur? Why?
6. What could be done to reduce conflicts and improve relationships with pastoralists?

FGDs with Mixed Groups (Community Leaders, Pastoralists, and Non-Pastoralists) ***(Optional, if safe and appropriate)***

1. What are the main challenges in managing shared land use in this community?
2. Are there examples of successful land use co-existence or cooperation between pastoralists and non-pastoralists? What lessons can be learned from these cases?
3. What strategies could be adopted to improve peaceful land use co-existence in this community?
4. How can traditional practices, government policies, and community initiatives work together to address land-use conflicts?
5. What role can each stakeholder (e.g., traditional leaders, government, pastoralists, farmers) play in promoting land use co-existence?

7.5. Appendix 5: Informed consent form

Consent Form for Towards Building Land Use Co-existence for Pastoralists and Non-pastoralists in Nanumba South District, Ghana.

(*YOU WILL BE GIVEN A COPY OF THIS INFORMED CONSENT FORM***)**

Please tick the appropriate boxes	**Yes**		**No**	
Taking part in the study				
– I have read and understood the study information dated (DD/MM/YYYY), or it has been read to me. I have been able to ask questions about the study and my questions have been answered to my satisfaction.	□		□	
– I consent voluntarily to be a participant in this study and understand that I can refuse to answer questions and I can withdraw from the study at any time, without having to give a reason.	□		□	
– I understand and agree that taking part in the study involves an audio-recorded interview and FDGs	□		□	
– I understand and agree that taking part in the study involves taking written notes as a summary	□		□	
Risks associated with participating in the study				
– I understand that taking part in the study involves the following risks: – I might be annoyed by the comments from your fellow participants in the focus group discussion. – I might annoy your fellow participants in the focus group discussion. – My fellow participants may disclose my identity, which is beyond the control of the researcher	□		□	
Use of the information in the study				
I understand that the information I provide will be used for academic purposes in partial fulfilment of the requirements for the degree of Master of Science in Geo-information Science and Earth Observation, providing and developing knowledge for possible measures to enhance land use co-existence and consequently reduce the land use conflicts.	□		□	
I understand that personal information collected about me that can identify me, including name, contacts, gender, marital status, education level, primary occupation, and social group association, will not be shared beyond the study team.	□		□	

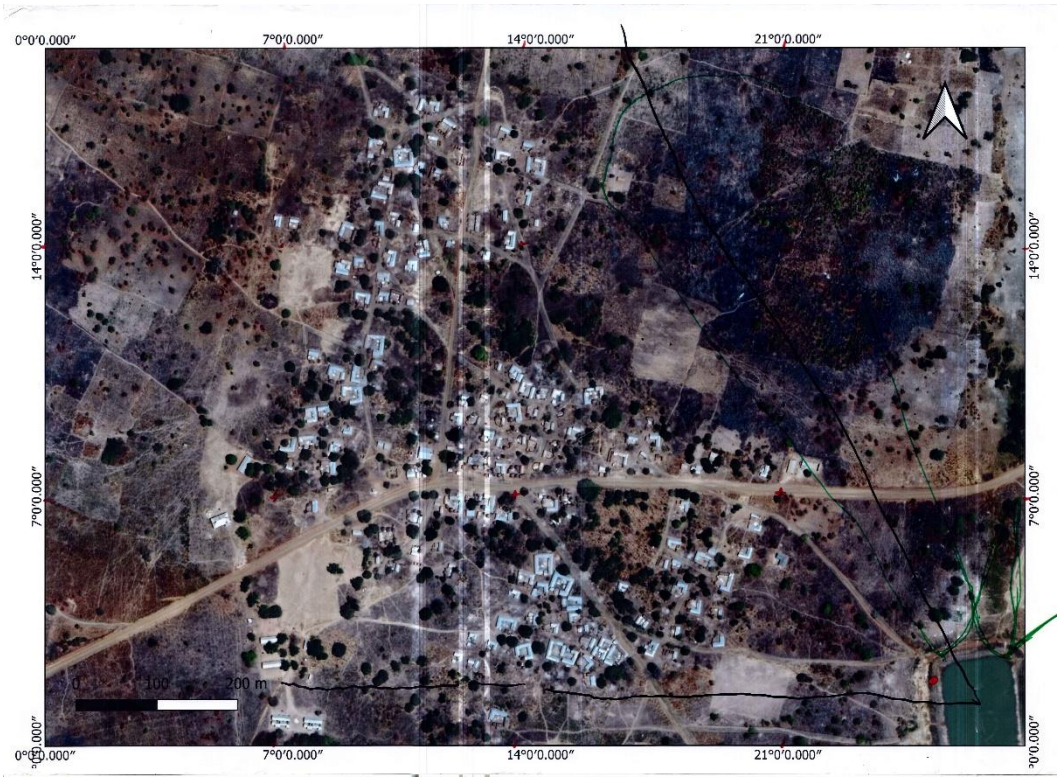
I understand that I can withdraw my data from the study at the latest by the end of data collection for key informant interview. However, during focus group discussion I can not withdraw my data since only the general overview of the group is captured and not individual information.	□		□	
I agree that my information can be quoted in research outputs	□		□	
Future use and reuse of the information by others				
I give permission for the anonymized transcripts of Key informant interview (KII) data that I provide to be archived and published in DANS data repository so it can be used for future research and learning and not for commercial use. I give permission for the anonymized transcripts of Focus group discussion (FGD) data that I provide to be archived and published in DANS data repository so it can be used for future research and learning and not for commercial use. I give permission for the anonymized survey (individual interview) data that I provide to be archived and published in DANS data repository so it can be used for future research and learning and not for commercial use.	□ □ □		□ □ □	
I understand that the anonymized KII, FGD and survey information I will provide can be shared with, and potentially used by, other researchers conducting similar studies.	□		□	
I give the researchers permission to keep my contact information and to contact me for future activities (field work II) of this research project.	□		□	
Signatures				
_____ _____ _____ Name of participant [printed] Signature Date				
For participants unable to sign their name, mark the box instead of sign I have witnessed the accurate reading of the consent form with the potential participant and the individual has had the opportunity to ask questions. I confirm that the individual has given consent freely. _____ _____ _____ Name of witness [printed] Signature Date				
I have accurately read out the information sheet to the potential participant and, to the best of my ability, ensured that the participant understands to what they are freely consenting.				

Offei Anyetei Michael _____ _____ Researcher name [printed] Signature Date				
Study contact details for further information: *Offei Anyetei Michael, m.a.offei@student.utwente.nl* **Contact Information for Questions about Your Rights as a Research Participant** If you have questions about your rights as a research participant, or wish to obtain information, ask questions, or discuss any concerns about this study with someone other than the researcher(s), please contact the Secretary of the Ethics Committee/domain Geo-Information Sciences of the Faculty of Geo-Information Sciences and Earth Observation at the University of Twente by ethicscommittee-geo@utwente.nl				

7.6. Appendix 5: Scanned Maps Used for Participatory Mapping Exercise

Below are maps used for the participatory mapping exercise for the other communities, namely Lungni, Gbungbaliga, and another map used for Kanjo

Map of Lungni used for participatory Mapping.



Map of Gbungbaliga used for participatory Mapping.

Map of Kanjo used for participatory Mapping.

7.7. Appendix 6: Buffer zones maps of Lungni and Kanjo